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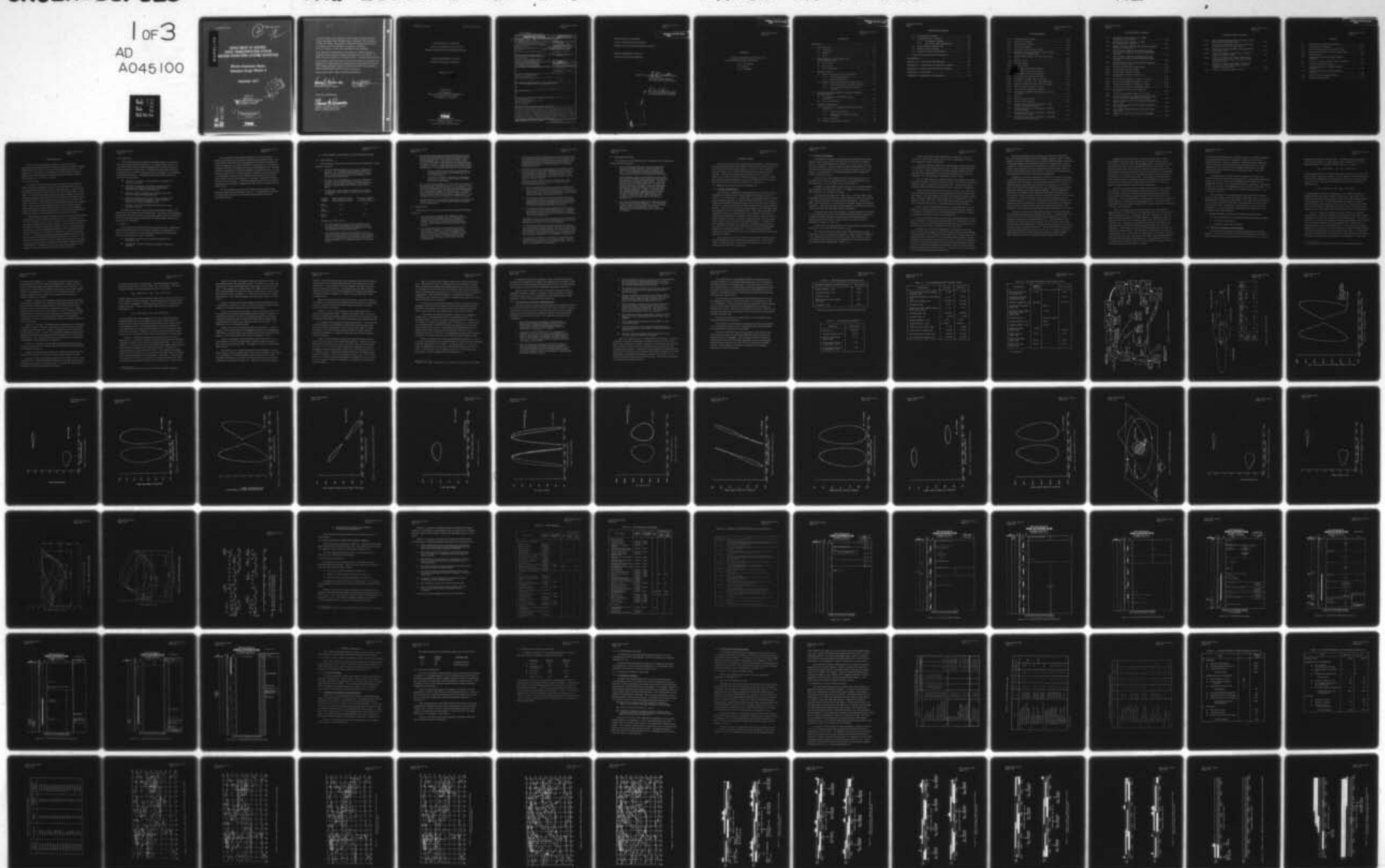

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DEPARTMENT OF DEFENSE SPACE TRANSPORTATION SYSTEM MISSION OPERATIONS SYSTEMS DEFINITION

Mission Assessment Report
Operations Design Mission A

September 1977

Prepared for

Headquarters
Space and Missile Systems Organization
Los Angeles Air Force Station
Los Angeles, California

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AUGUST 1977

TRW
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This final report was submitted by TRW Defense and Space Systems Group, One Space Park, Redondo Beach, California, under contract F04701-75-C-0025, with the Space and Missile Systems Organization, Los Angeles Air Force Station, Los Angeles, California. LTC J.F. Garber, LVRE, was the SAMSO Project Engineer.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

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SAMSO-TR-77-116

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SPACE TRANSPORTATION SYSTEM
MISSION OPERATIONS SYSTEMS DEFINITION

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents the results of analysis of a near term DOD geosynchronous near equatorial payload deployment mission utilizing the Space Shuttle vehile in conjunction with an Interim Upper Stage (IUS). This issue of the report concentrates on development of a nominal mission plan for a particular launch date and time. Such items as attitude timelines, approximate RCS/OMS propellant utilization histories, ground tracks, and ground station coverage timelines are included. Principal emphasis is placed on development of an IUS deployment timeline for near term missions.

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DEPARTMENT OF DEFENSE

SPACE TRANSPORTATION SYSTEM

MISSION OPERATIONS SYSTEMS DEFINITION

MISSION ASSESSMENT REPORT

OPERATIONS DESIGN MISSION A

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PREFACE

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1. INTRODUCTION

This document presents the results of analysis of a DOD geosynchronous equatorial payload deployment mission utilizing the Space Shuttle Vehicle in conjunction with the Interim Upper Stage (IUS). The analysis was conducted by TRW Defense and Space Systems Group in support of the DOD STS Mission Operations System Definition (MOSD) Study (Contract No. F04701-75-C-0025).

1.1 BACKGROUND

In 1980, the DOD will begin to utilize the Space Transportation System (STS) to accomplish a variety of payload deployment missions. For approximately the first two years of operation (i.e., until December 1982) all DOD missions will be launched from the Kennedy Space Center (KSC). NASA, the developing agency for the Space Shuttle, will provide all mission planning and mission control functions for the Orbiter vehicle during this period. Every DOD-dedicated mission in the 1980-82 time-frame requires use of the IUS to place the satellite payload in its required orbit. DOD, the developing agency for IUS, will provide the mission planning and mission control functions for the IUS on all DOD flights. Thus, this period of operations (1980-82) is characterized by joint DOD/NASA operations for accomplishment of DOD mission activities.

The DOD Mission Model (Reference 1) calls for IUS missions deploying satellites in three classes of mission orbits: (1) geosynchronous, (2) 12-hr elliptical, and (3) 12-hr circular. Representative mission plans are being generated for each of these classes. Other types of DOD IUS Missions are contained in the Mission Model, but do not impose driving requirements or are insufficiently defined to warrant detailed analysis. The geosynchronous mission plan is referred to as Operations Design Mission A. A specific geosynchronous payload deployment mission has been selected to represent the geosynchronous class of missions. The Operations Design Mission A plan presented in this report is based upon the specific requirements associated with the Defense Support Program (DSP) Satellite. Variations to the mission plan required by the Fleet Satellite Communications (FSC) Program are also identified.

1.2 OBJECTIVE

One of the principal objectives of the MOSD study is to define the DOD MOS requirements and interfaces. In support of this objective, a set of DOD STS missions has been identified which fully represents the mission operations requirements. Detailed mission profiles are being developed for each of these missions with major emphasis on development of operations timelines. Development of these timelines serves the following major purposes:

- establishes confidence in the ability to accomplish the mission as planned,
- identifies limitations in the NASA-developed system (hardware and software) which may compromise achievement of DOD mission objectives,
- identifies support requirements imposed on the DOD control center and tracking network,
- identifies significant open issues whose resolution DOD needs to accomplish or monitor in order to ensure satisfaction of mission objectives, and
- provides a basis for development of the DOD mission operations concept.

An integral part of the mission profile development activity is the generation of the Orbiter and IUS trajectories. By means of this trajectory planning and generation function, requirements which must be satisfied by the DOD Conceptual Mission Design and IUS Flight Design computer programs are also identified.

1.3 SCOPE

In developing this mission profile and operations plan, considerable effort has been devoted to the collection, validation, and integration of past and current analysis results with the ultimate goal of producing a mission plan characterized by the following:

- satisfaction of all known DSP mission objectives and constraints, and
- compatibility with the evolving NASA mission operations concepts.

The first issue of this report (Reference 11) was based upon a generic geosynchronous payload and a generic liquid propellant IUS. This second issue of the Operations Design Mission A document concentrates on the development of a nominal STS/DSP mission plan for an arbitrarily selected launch date and utilizes the Boeing solid propellant IUS. Attitude schedules, approximate RCS/OMS propellant utilization histories, ground tracks, ground station coverage timelines, and basic trajectory data have been developed to support both the MOSD study and other STS-related studies which require representative mission data in support of tradeoff and performance analyses. Principal emphasis is placed on the Orbiter/payload timeline through IUS deployment because this is the area of major DOD concern.

The IUS configuration used in this study is the two-stage Boeing proposal configuration (References 2 and 3). IUS deployment operations are based on the results of IUS-related working group meetings as well as Reference 3.

2. CONCLUSIONS, OPEN ISSUES, AND RECOMMENDATIONS

2.1 CONCLUSIONS

The following conclusions have resulted from the Operations Design Mission A analysis.

1. All known DSP requirements, exclusive of deployment accuracy, can be satisfied with currently baselined Orbiter, IUS, and Mission Operations System capabilities. DSP deployment accuracy requirements were not addressed in this study.

2. All known FSC requirements, exclusive of deployment accuracy, can be satisfied with currently baselined Orbiter, IUS, and MOS capabilities. FSC deployment accuracy requirements were not addressed in this study.

3. The baseline, fully loaded, two-stage IUS is capable of deploying a DSP satellite at any specified longitude as follows:

Transfer Type	Latest Required Transfer Burn Time, hr, GET	Maximum Longitude Error, deg†
Short (3.5 hr)	27.5	±4.5
Long (9-11 hr)	27.5	0
Short or Long	9.5	±6.5

†Exclusive of GN&C errors.

4. The DSP requirement to establish a specified right ascension of the ascending node of the final orbit can be satisfied with the baseline, fully loaded, two-stage IUS regardless of Orbiter launch time.

5. The requirements to deploy the IUS/DSP in darkness and to issue all the IUS commands from ground stations result in a daily Orbiter launch window of approximately 45 min. By imposing this launch window, the deployment constraints can be satisfied during two consecutive orbits.

6. For payload weights approaching the performance limit of the IUS, the right ascension of the ascending node of the Orbiter parking orbit must be nearly the same as that of the final payload orbit. This imposes a launch window which is not generally compatible with the window imposed for darkness control. Such missions are unfeasible unless a means is found to uncouple the darkness and station pass requirements. Two possible solutions have been identified:

    1. provide continuous IUS commanding capability so that deployment need not be accomplished in view of ground stations, or

    2. eliminate the darkness constraint on deployment operations by means of orbiter and/or satellite subsystem modifications.

7. The earliest that deployment of the IUS/DSP or IUS/FSC can be accomplished by a three-man crew is an support of the fourth descending node IUS transfer burn opportunity. Crew skill level requirements are no greater than those expected to be developed in support of NASA missions. The typical mission plan presented in this report is based upon the fourth ascending node IUS transfer burn opportunity in order to deploy the satellite at the chosen 137 degree longitude

8. Estimated Orbiter OMS and RCS propellants for performance of the mission are well within Orbiter internal propellant storage capabilities.

2.2 OPEN ISSUES

Several key open issues exist with regard to Operations Design Mission A.

1. The operations constraints and limitations of the Remote Manipulator System are not well understood. Constraints (or the absence thereof) on Orbiter attitude control and the duration of RMS operations are key considerations in developing the deployment timeline.

2. Safe separation distances for enabling the IUS RCS and SRM are undefined. A distance of 200 ft has been assumed in this analysis for enabling the RCS and 10 nautical miles for enabling the SRM. Greater distances would require modifications to the operations plan and, possibly, to the Orbiter and IUS configurations.

3. The Orbiter method of navigation has recently been changed from onboard to ground-based until GPS is operational. The accuracy of the state vector transfer to the IUS and the time constraints thereon are dependent on the mechanization of the navigation technique. The mechanization is not fully defined at this time.

4. IUS GN&C performance characteristics and Orbiter navigation accuracy are not firmly defined because the systems are still under development. Therefore, analysis of satellite deployment accuracy has not been performed. The viability of the mission plan is dependent on the results of such an accuracy analysis.

   Ability to satisfy mission accuracy requirements could potentially be affected by one or more of the following mission plan characteristics.

   - The time available to derive an accurate Orbiter state vector, on the ground, and transmit it to the Orbiter for transfer to the IUS may be insufficient. The accuracy of the initial state vector is critical to the IUS navigation, onboard targeting, and guidance functions.

   - The time between IUS initialization (attitude and state) by the Orbiter and the first IUS burn may be excessive. Degradation in state and attitude determination accuracy during this time period will affect the accuracy of the IUS onboard targeting and guidance functions.

   - The time between the first and second IUS burns may be excessive should a long transfer be used. Transfer coast periods up to 11 hours are available, but degradation in the onboard state vector accuracy may disallow use of such trajectories.

   All aspects of the mission plan from initiation of deployment operations to completion of the satellite deployment could be affected by the results of an accuracy analysis.

5. IUS SRM effluent dynamics and their effects are unknown. These characteristics will influence the required separation for contamination avoidance between the Orbiter and IUS for performance of the IUS transfer burn. The dynamics of the SRM effluents will also affect the targeting of the SRM burns and subsequent operations to avoid satellite contamination.

6. The maximum allowable time between IUS deployment and completion of the mission is not clearly defined. Battery power, RCS propellant and overall vehicle reliability may limit the acceptable mission duration.

2.3 RECOMMENDATIONS

The following recommendations have resulted from the Operations Design Mission A analysis.

1. It is recommended that an RF link be implemented between the Orbiter and IUS. This link would be used to issue deployment-related commands to the IUS. The link would also be used to verify transmitter operation prior to IUS release from the RMS.

   Implementation of this recommendation would greatly enhance the flexibility of the mission plan by removing the dependence on ground station passes. It would also increase the Orbiter launch window on the DSP mission from 45 min to nearly 24 hr. It would also facilitate numerous contingency IUS/DSP deployment opportunities rather than only one as provided with the baseline capability. Finally, it would provide the capability to perform geosynchronous missions in which the satellite weight approaches the performance limit of the IUS. These missions are currently considered unfeasible as discussed in Section 2.1.6.

2. It is recommended that analyses be conducted to close the open issues cited in Section 2.2. The resolution of these issues may have significant impacts on DOD flight operations and planning. Thus, early resolution would facilitate planning for early DOD STS flights.

3. MISSION DESIGN

This section presents the Operations Design Mission A requirements, describes the nominal mission profile, and presents the supporting rationale for development of the mission plan. Figures 3-1 and 3-2 present overviews of the major Orbiter and IUS operations in support of this mission. Throughout the following discussion, the term "payload" is used to mean both the IUS and the attached satellite, but does not include the supporting payload equipment which is not deployed from the Orbiter. DSP and IUS data were taken from References 2 through 5.

3.1 MISSION REQUIREMENTS AND DESCRIPTION

3.1.1 Mission Requirements

The objective of Operations Design Mission A is to deploy one DSP satellite in a geosynchronous, nearly equatorial orbit as specified in Table 3-1. A launch date of 1 January 1981 is arbitrarily defined and does not necessarily represent a currently planned DSP launch. The requirements for inclination and right ascension of the ascending node result from a desire to control the variation in orbital inclination during the satellite's lifetime. Because of solar and lunar perturbations on the satellite's orbit, the inclination is a time-varying parameter. DSP requires that the orbit inclination not exceed 3 deg during the 5-year lifetime of the satellite. Analysis has shown that the inclination will not exceed 3 deg if the initial orbital inclination is near 3 deg and the right ascension of the ascending node is in the range of 250 deg to 340 deg (Reference 6). Selection of a nominal target inclination of 2.1 deg and an ascending node at 292 deg for a 1981 launch allows a great tolerance for error in establishing the deployment inclination (Reference 6). The desired DSP deployment longitude is representative and does not necessarily reflect an actual DSP operational location.

The launch time of 14 hr 50 min GMT was chosen to satisfy simultaneous lighting and ground station pass requirements. These requirements are satisfied on two consecutive revolutions even if the launch occurs up to 45 min later than planned.

3.1.2 Mission Description

The Shuttle ascent phase begins when the thrust builds up to equal vehicle weight which occurs at exactly 14 hr 50 min GMT and defines GET = 0. It ends at OMS insertion into the 55- x 150- n.mi. orbit at a 28.5 deg inclination. Mission events are summarized in Section 4. The ascent will be standardized to agree with NASA design for any due east launch. Event schedules and trajectory shaping will then depend primarily on payload weight.

In this mission, the subphases of ascent are vertical rise, roll, and pitch, open loop steering, SRB cut-off, closed loop SSME thrust, ET separation, coast, and OMS insertion burn (OMS-1).

At liftoff, the three SSME's and two SRB's are on; the three SSME's are throttled to the 100% power level. The SSME's are throttled up to 109% beginning 3.5 seconds after liftoff.

The roll and pitch phase lasts until 16 sec. The roll angle is predetermined by the launch azimuth, and the pitch kick is chosen to provide good initial conditions for the open-loop steering phase. During this phase, the roll maneuver is limited by the maximum angular acceleration constraint. The first-stage steering was designed to maximize performance within structural loads and flight control constraints.

During the open loop steering phase, a modified gravity turn in pitch is used without yaw steering. The NASA-developed standard pitch angle-of-attack and SSME throttle profiles are flown through the maximum dynamic pressure (Q) region. These profiles are summarized in Appendix A (Figure A-1 and A-2).

At 115.6 sec, the expended SRB's are jettisoned; the resultant impact point is 28.6 deg North lat, 78.0 deg West long.

The closed-loop steering phase begins after SRB jettison using Generalized Linear Tangent (GLT) guidance. SSME thrust is maintained at the maximum power level until 235 sec GET, then reduced to 100%. The target MECO conditions are the standard set used for all DOD and NASA KSC launches (Appendix A, Table A-5).

MECO, the point at which the SSME's are shutdown, occurs at 8 min 9 sec with a conic apogee of 81.0 n.mi. and perigee of 15 n.mi. The propellant residual is 44,400 lb.

Eleven seconds after MECO, the external tank is jettisoned and the RCS engines are used to add 4 ft/sec in the -Z (heads-up) direction with a 5- sec burn. The free-falling ET breaks up during reentry with the center of mass impacting at 28.6 deg South latitude and 83.3 deg East longitude. The RCS translate is followed by a 20-sec coast.

The two OMS engines are ignited at 08:45 GET with the closed-loop guidance steering the vehicle to the target orbit. The OMS burn terminates when the target is reached at 10 min 40 sec GET. The ME propellant dumping is initiated during this OMS burn and is described in Appendix A.

Following OMS engine shutdown in the 55- x 150- n.mi. orbit, the crew configures the Orbiter for on-orbit operations while coasting to the first apogee. The first apogee is reached 34 min after insertion, at which time a 174 ft/sec OMS burn lasting 1 min 35 sec is performed to circularize the orbit at 150 n.mi. This orbital altitude has been adopted by joint DOD/NASA agreement as a standard value for study purposes.

Following the circularization maneuver, the payload bay doors are opened and, except for the short periods of time when specific attitudes are required, the payload bay is continuously pointed earthward for payload thermal control and communication purposes.

Following the payload bay door opening, IUS/DSP deployment activities are initiated. The earliest release of the IUS is scheduled to be completed by 2 hr 43 min GET so that the first IUS burn can be performed in the vicinity of the fourth ascending node (5 hr 42 min GET).

Preparation of the IUS for deployment is performed onboard the Orbiter and includes alignment of the IUS inertial reference and updating of the IUS state vector. DSP and IUS telemetry data are transmitted to the ground during the HTS and VTS remote tracking station passes; approximately 12 min are allowed for telemetry readout. Communication between the DSP and RTS ground stations is performed independent of the Orbiter and IUS communication systems and is required during all station passes after the payload bay doors are opened. A minimum of 3 min of each pass is allocated to DSP telemetry transmission.

Following completion of all checkout and preparation operations, the IUS is deployed using the Remote Manipulator System (RMS). Orbiter attitude is inertially stabilized prior to initiating RMS deployment operations. During RMS deployment through IUS release, all Orbiter attitude control is disabled. RMS operations will be performed in darkness to protect the satellite from exposure to direct sunlight and to preclude light reflected from the DSP impairing the crew's vision. Just prior to IUS release, the IUS transmitter is turned on and verified through GTS.

Shortly after the IUS is released (at 2:46 GET) the Orbiter performs a 4-fps RCS translate in the forward direction. Following this Orbiter-IUS separation burn, the Orbiter is oriented such that the Orbiter/IUS line-of-sight through the upper observation windows is maintained. In order to provide the required DSP thermal control, the IUS must perform thermal maneuvers within 20 min after entering sunlight. The IUS attitude control system is enabled at 02:59 GET from HTS after the Orbiter has moved away to a safe separation distance (presently undefined, but assumed to be 500 ft). Forty-five minutes after the Orbiter separation burn, a separation distance of 5.9 n.mi. is achieved at which time an Orbiter circularization burn is performed. At this point in the mission, the Orbiter becomes relatively inactive (for DOD mission planning purposes) while waiting for its earliest deorbit opportunity which occurs about 17 hr. later.

The active portion of the IUS mission begins at 2:59 GET when the RCS enabling commands are transmitted from HTS. At approximately 4:15 GET (1 hr 29 min after the 4-fps Orbiter RCS translate) the IUS SRM enabling commands are transmitted from GTS. Approximately 2 hr 59 min after the 4-fps Orbiter RCS translate, the IUS arrives at the fourth ascending node burn opportunity. IUS transfer burn ignition occurs 3 min after the equator crossing at 5:45 GET. The transfer burn is performed in a fixed inertial direction and lasts 2 min 27 sec. As soon as the burn is terminated, the IUS is maneuvered to the velocity correction attitude and a velocity correction (if required) is made using the IUS RCS.

During the post-transfer burn coast period which lasts 3.30 hr, the IUS/DSP is put into a slow-roll maneuver with a minimum rate of 0.75 deg/sec oriented such that the longitudinal axis is maintained normal (± 30 deg) to the solar vector to satisfy DSP thermal constraints. The attitude and maneuver rate may be interrupted for periods of up to 14 min for the purpose of transmitting telemetry data to the ground or performing an IUS burn. There will be no more than six dip-outs and no less than 30 min between two consecutive dip-outs. The transfer orbit satisfies the DSP constraint that the maximum duration of the earth/sun eclipse from injection into transfer orbit to DSP separation is 45 min. During this coast, the DSP transmits telemetry data continuously.

The IUS circularization burn ignition occurs at 09:07 GET and lasts 1 min 42 sec. The IUS first stage is separated just prior to this burn. The circularization burn is performed such that subsequent operations do not carry the IUS/DSP through the effluent cloud from the IUS solid motor burn. This burn establishes a geosynchronous orbit over a particular earth longitude. Following the circularization burn, the IUS maneuvers to the RCS velocity correction attitude and a velocity correction (if required) is made using the IUS RCS.

After circularizing at synchronous altitude, the IUS coasts for approximately 5 min and orients its longitudinal axis within ± 30 deg of the positive velocity vector. IUS angular rates are reduced to less than 0.5 deg/sec about each axis prior to DSP separation. Separation occurs at a time such that there is no earth/sun eclipse for 2 hr prior to and 2 hr after the event. Separation is scheduled such that two RTS stations are within line-of-sight of the satellite beginning at least 15 min prior to separation. The satellite must be at least 5 deg away from the sunline to at least one of these RTS's. The DSP further constrains the mission by requiring the moon, as seen from the spacecraft, to be greater than three degrees from the earth's horizon in the first and second earth acquisition corridors following spacecraft deployment. The acquisition corridors are defined as the periods between 5:30 and 6:30 AM and between 5:30 and 6:30 PM local time at the satellite subpoint.

All IUS thruster operations are inhibited just prior to satellite separation and a spring-induced relative separation velocity of 1 ±0.3 ft/sec is imparted when the satellite is released. Following satellite separation, the IUS performs a post-separation maneuver to prevent the IUS from colliding with the satellite and from passing within the line-of-sight between the satellite and the earth in subsequent orbits. The IUS is then deactivated.

Approximately 11 hr after the IUS completes its mission, the Orbiter reaches its nominal deorbit opportunity. The nominal opportunity is selected to be the first deorbit opportunity to KSC (following IUS deployment and after a crew rest period) having a crossrange requirement of 500 n.mi. or less. This opportunity occurs at 20 hr 15 min GET. The desired entry interface conditions were obtained from Reference 7 and are shown in Table 3-2.

The deorbit burn is nominally performed using two OMS engines; however, the maneuver must be designed to allow the burn to be successfully performed with only one OMS engine. The nominal deorbit maneuver is a 297 ft/sec retrograde OMS burn. The burn lasts 2 min 11 sec and entry interface (400- Kft altitude) is reached 22 min 44 sec after burn termination. An out-of-plane ΔV component may be added to the burn to reduce excess OMS propellant.

3.2 MISSION DESIGN ALTERNATIVES/TRADEOFF ANALYSES

Two tradeoff analyses were performed during the mission analysis.

1. IUS Trajectory Selection
2. Deployment Operations Timeline

3.2.1 IUS Mission Design Tradeoff Analysis

The first tradeoff analysis performed in developing the mission design was concerned with the time of the first IUS burn. If the IUS were sized for the DSP mission, the first burn would occur at a node, and the

second burn would occur 180 deg away. The plane changes associated with the burns would be 2.1 deg and 24.3 deg, respectively. For such a Hohmann transfer, the following impulsive ΔV's are needed:

$$\Delta V_1 = 8032 \text{ ft/sec} \quad \text{and} \quad \Delta V_2 = 5663 \text{ ft/sec}$$

and the right ascension of the ascending nodes of the Orbiter parking orbit and IUS target orbit must coincide. The two-stage IUS with the characteristics shown in Appendix A would develop such ΔV's for a satellite weighing about 5300 lb. For the much lighter DSP, the IUS will impart the following ΔV's:*

$$\Delta V_1 = 9079 \text{ ft/sec} \quad \text{and} \quad \Delta V_2 = 7952 \text{ ft/sec}$$

To accommodate this excess performance, a non-optimal transfer is employed which opens up the departure point into a wide window and allows transfer from parking orbits with any value of the right ascension of the ascending node. For calculating these non-optimum transfers, conic trajectories and impulsive burns were used. The results for DSP are shown in Figures 3-3 through 3-14 for the chosen launch time which yields a 151.81- deg parking orbit right ascension of the ascending node.

Figure 3-3 shows the departure window for Mission A with the described IUS. The figure identifies the geometry of all possible transfer trajectories and forms the basis for all subsequent figures. The abscissa of Figure 3-3 is the time of the first IUS burn on the parking orbit measured from the fourth ascending node of the parking orbit. Negative times indicate positions before reaching the node. The ordinate is the angular position of the second IUS burn measured from the point where the parking orbit ascends through the target orbit plane (lower node). Less than 180 deg indicates that insertion is done before reaching the upper node (where the parking orbit descends through the target orbit plane). These nodes

*The IUS SRM's cannot thrust terminate before propellant depletion.

are illustrated in Figure 3-15. The Hohmann transfer would transfer the satellite from the lower node to the upper node. A gap around the lower node indicates that near-Hohmann transfers are not possible. The figure shows a discontinuous departure window of several minutes length instead of the single point characteristic of a Hohmann transfer. Two transfer trajectories are available at every point in the departure window except the extremities.

Figure 3-4 presents the longitudes at final orbit insertion resulting from transfers initiated in the vicinity of the fourth ascending node. The abscissa of this and all subsequent figures is the time of the first IUS burn in minutes, measured from the equatorial crossing (i.e., fourth ascending node), just as it was on Figure 3-3. The "+" markers identify those trajectories which have their injection point beyond the upper node (compare with Figure 3-3) and provide the means for obtaining consistent data sets from the subsequent plots which show multiple solutions at each time point.

Figures 3-5 through 3-14 show the main characteristics of the possible transfer orbits as a function of the time of the first IUS burn relative to the fourth ascending node. Figure 3-5 presents the inclinations of the possible transfer orbits. Figure 3-6 presents the difference between the right ascension of the ascending node of the transfer orbit and that of the parking orbit. (The right ascension of the ascending node of the parking orbit depends on the launch time and azimuth.)

Figure 3-7 shows the central angles between the first and second IUS burns which start with well over 180- deg values but decrease rapidly in the departure window.

Figure 3-8 presents the transfer times which are about three times higher when departure is made before reaching the target orbit plane.

Figure 3-9 shows the perigee altitudes of the transfer orbits. The solid part of the curves depicts those trajectories on which the IUS passes through perigee during the transfer coast. The dotted line depicts those trajectories which start beyond their perigees.

second burn would occur 180 deg away. The plane changes associated with the burns would be 2.1 deg and 24.3 deg, respectively. For such a Hohmann transfer, the following impulsive ΔV's are needed:

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$$\Delta V_1 = 9079 \text{ ft/sec} \quad \text{and} \quad \Delta V_2 = 7952 \text{ ft/sec}$$

To accommodate this excess performance, a non-optimal transfer is employed which opens up the departure point into a wide window and allows transfer from parking orbits with any value of the right ascension of the ascending node. For calculating these non-optimum transfers, conic trajectories and impulsive burns were used. The results for DSP are shown in Figures 3-3 through 3-14 for the chosen launch time which yields a 151.81- deg parking orbit right ascension of the ascending node.

Figure 3-3 shows the departure window for Mission A with the described IUS. The figure identifies the geometry of all possible transfer trajectories and forms the basis for all subsequent figures. The abscissa of Figure 3-3 is the time of the first IUS burn on the parking orbit measured from the fourth ascending node of the parking orbit. Negative times indicate positions before reaching the node. The ordinate is the angular position of the second IUS burn measured from the point where the parking orbit ascends through the target orbit plane (lower node). Less than 180 deg indicates that insertion is done before reaching the upper node (where the parking orbit descends through the target orbit plane). These nodes

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*The IUS SRM's cannot thrust terminate before propellant depletion.

Figure 3-10 shows the apogee altitudes of the transfer orbits. In the earlier portion of the departure window, the solid curves represent trajectories on which the IUS passes through apogee prior to the second burn. These apogees are 3200 to 5900 n.mi. higher than the desired final orbital altitude and explain the higher transfer times in the earlier portion of the window of Figure 3-7. In the later portion of the window, the apogees are not travelled through, and the transfer times are much lower.

Figure 3-11 presents the pitch angle for the first impulsive burn. A comparison of Figures 3-11 and 3-9 shows that the pitch angle must be negative for transfer trajectories which contain perigee.

Figure 3-12 shows the yaw angle for the first impulsive burn. Yaw is measured in the usual local horizontal system, positive clockwise. A comparison of Figure 3-12 and 3-5 indicates that positive yaw angles reduce the inclination of the transfer orbit below the inclination of the parking orbit (28.5 deg) for the ascending node case illustrated. The opposite is true for descending nodes.

Figure 3-13 shows the pitch angle for the second burn. Pitch is positive in the earlier portion of the departure window in correspondence with Figure 3-10 which shows that insertion occurs after passing through apogee. In the later portion of the window, the opposite occurs.

Figure 3-14 presents the yaw angle for the second burn. Yaw is always negative for the illustrated case in which transfer originates in the vicinity of an ascending node. The opposite is true for a descending node transfer.

The selection of a transfer trajectory from the departure window can be based on many considerations; in the case of the DSP, it was based on a requirement to insert the satellite into its final orbit at a given longitude (137 deg W). To achieve insertion at 137 deg W, two transfer trajectories are available (Table 3-3). There are no clear advantages;

however, if the first case is chosen as a nominal mode, then the second case can serve as a backup mode because the burn starts later for the second case. In the absence of an error analysis, the first trajectory has been chosen for Mission A. The tolerance on the right ascension (90°) and the tolerance on the DSP longitude ($\pm 6^{\circ}$) opens up the departure window to 9 minutes if departure is made in the vicinity of the fourth ascending node.

After the selection of the transfer burn time, a precision solution accounting for gravitational perturbations and finite burns was generated. Table 3-4 shows the parameters of the transfer trajectory resulting from the precision simulation.

Tables 3-3 and 3-4 show that the conic approximation has yielded very good initial values. Neither the transfer time nor location has to be significantly changed in order to account for the finite burn time and gravity perturbations. The orbital parameters agree reasonably well.

Two supplementary analyses have been performed. The first determined the duration of the departure window given that the target right ascension of the ascending node is free to vary in the range of 250 deg to 340 deg. The second analysis determined the accessible satellite deployment longitudes as a function of the node near which the transfer burn is performed.

Figure 3-18 illustrates the departure window for short duration transfers in the vicinity of the fourth ascending node. Solutions to target orbits having right ascensions of the node of 250, 280, 310 and 340 deg are shown. For a desired satellite deployment longitude of 137 deg, it is apparent that as the figure moves from the $\Omega = 250$ deg position to the $\Omega = 340$ deg position, all possible solutions will lie in a continuous time span of 4.1 minutes. This is labelled Δt_1 in Figure 3-18. If the ± 6 deg tolerance on satellite deployment longitude is considered, then a continuous time span of 9 minutes, labelled Δt_2, is available in which there is always a solution.

Figure 3-19 shows the analogous situation for long duration transfers. The departure window is illustrated in a general fashion with the desired deployment longitude bisecting the figure when Ω equals 340 deg. As Ω changes from 340 to 250 deg, two departure intervals are generated. These are labelled Δt_1 and Δt_2 and are 2.45 min and 2.20 min in duration, respectively. If the ±6 degree tolerance on deployment longitude is considered, then solutions are found in a continuous time span of 9.4 min which is labelled Δt_3 in the figure.

This analysis shows that the freedom allowed in selecting both the deployment longitude and the right ascension of the ascending node for the DSP mission permits the first IUS burn to the performed anywhere within a particular time span rather than at a few discrete points.

To investigate the feasible longitude coverage by IUS, departure windows were also generated for the 4-th descending and the 5-th descending nodes. Only the insertion longitudes changed † (Figures 3-4, 3-16 and 3-17.) Next, the longitude zones of Figures 3-4, 3-16 and 3-17 were extrapolated to include all possible burn opportunities during the first two days of the mission. In performing this extrapolation, it was assumed that safety considerations required the Orbiter crew to be awake during the first IUS burn. The extrapolation includes the maximum allowable crew sleep cycle shift of 1 hr/day as recommended by NASA.

Figure 3-20 shows that, if only short duration transfers (~ 3.5 hr) are used, all longitudes are accessible within 4.5 deg by the 19th descending node burn opportunity (27.5 hr GET). If long transfers (9 to 11 hr) are used, all longitudes are accessible by the 19th descending node (27.5 hr GET). Long transfers can be expected, however, to result in larger dispersions in satellite deployment orbit parameters.

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† Effect of the nodal regression was too small to show on the other graphs.

A significant result of this analysis is that, if both long and short transfers are acceptable to a payload, all longitudes are accessible within ±6.5 deg by the 7th descending node which occurs only 9.5 hr after liftoff. This compares favorably with the stated DSP requirement of ±6 deg.

These results are peculiar to the DSP mission, because they are dependent on satellite weight. In general, lighter satellites are capable of reaching wider regions of longitude from each node and heavier payloads have a lesser longitude placement capability.

3.2.2 Crew Activities Timeline Tradeoff Analysis

The second tradeoff analysis was performed for the purpose of determining the best solution to the conflicting operational constraints imposed on the Crew Activities Timeline during the time period between Orbiter payload bay doors opening and enabling IUS attitude control (following IUS/DSP release from the Orbiter). The following constraints were considered.

1. It is highly desirable to activate, verify operation, deploy, and release the IUS/DSP as early as possible in the flight, consistent with longitude placement requirements, because of DSP thermal control considerations. (References 2, 3, and 5).

2. Deployment of the IUS/DSP must be accomplished in darkness in order for the crew to visually perform the task in a safe manner. In sunlight, the highly reflective exterior of the DSP would interfere with the visibility of the crew. DSP thermal control constraints also must be considered (see Item 6).

3. The time between the release of the IUS from the payload bay mounting cradle and the Orbiter separation burn must be minimized because during this time period the Orbiter attitude control is inhibited and the Orbiter and IUS are free to rotate as an assembly or independently (following IUS/DSP release).

4. The IUS transmitter must be turned on by an RTS command and the operation of the transmitter must be verified by an RTS while the IUS/DSP is outside of the payload bay with the RMS attached (Reference 4).

5. The maximum delta velocity for the Orbiter separation is 4 ft/sec to minimize the contamination hazard to the DSP satellite.

6. After the IUS/DSP is released from the RMS, the IUS attitude control system must be enabled within 20 min after entering sunlight in order to provide thermal attitude maneuvers for the DSP (Reference 5).

7. The IUS attitude control cannot be enabled until a safe separation distance (200 ft, assumed) is achieved between the Orbiter and IUS/DSP. The IUS SRM can not be armed until the Orbiter and IUS/DSP achieve a safe separation distance (10 n.mi. assumed).

8. The RTS ground station availability is trajectory fixed by the 28.5-deg orbital inclination and the 150- n.mi. altitude.

9. The daylight/darkness periods for the flight are fixed by the launch time.

10. Times required for various payload deployment crew activities and Orbiter operations are fixed by NASA-JSC (Reference 9).

11. The time of the IUS transfer burn is determined by the required satellite deployment longitude.

There are requirements to command the IUS transmitter on after the IUS/DSP is extended on the RMS, to enable the IUS RCS within 20 min after release and after the Orbiter separates a safe distance (200 ft) from the IUS, and to perform these two tasks by means of commands from remote tracking stations. Analysis of the ground track revealed that only the GTS and HTS stations passes between 02:41:00 and 03:00:00 GET would satisfy these conditions and would also allow the IUS transfer to occur near the fourth ascending node at 05:45:06 GET. This is the solution that is reflected in the nominal timeline.

The requirement to accomplish the RMS to IUS attachment and IUS/DSP deployment in darkness dictated that these crew activities be scheduled during an orbital night pass. This requirement was met by (1) minimizing the crew activities that must occur sequentially between the start of the RMS to IUS attachment and the IUS/DSP release event and by (2) scheduling the time of Orbiter launch to provide a night pass which starts at 02:16:00 GET.

The possibility of performing the RMS attachment to IUS and payload deployment sequence on either the first or second pass over GTS was investigated. It was determined that the launch time could be delayed up to 45 min and still achieve proper daylight/darkness conditions to schedule IUS release on the first or second pass over GTS. This 45- min launch window allows the IUS transfer burn to be performed at the fourth and fifth ascending node.

The timeline solutions to constraints 2, 4, and 6 satisfy all the identified deployment constraints.

Other timeline and launch time solutions to the described problem were investigated, but this was the only solution found which satisfied the previously described eleven constraints.

Orbiter and IUS/DSP design changes which would eliminate the launch window constraint and provide additional mission contingency capabilities were investigated. By providing an RF link between the Orbiter and the IUS, the IUS enable commands could be accomplished without having to pass over an RTS within 20 min after the IUS/DSP release. This capability would allow constraint 6 to be satisfied independent of the RTS coverage.

Table 3-1. DSP Deployment Orbit Requirements

Satellite Deployment Orbit Parameters	Requirement
Apogee altitude, n.mi.	19323
Perigee altitude, n.mi.	19323
Inclination, deg	2.1
Right ascension of ascending nod, deg	292
Longitude,* deg	137W

* Does not necessarily represent an operational location.

Table 3-2. Nominal Entry Conditions

Parameter	Target Value
Altitude, ft	400,000
Inertial Velocity, ft/sec	25,760
Inertial Flight Path Angle, deg	-1.34
Downrange Distance to Landing Site, n.mi.	3,710
Crossrange Distance to Landing Site, n.mi.	≤ 500

Table 3-3. Conic Parameters of the Transfer Orbits

Parameters	1st Case	2nd Case
Time of first burn from Equator crossing, min	5.087	5.837
Argument of latitude at insertion, deg	31.47	35.68
Insertion longitude, deg	137.23W	137.25W
Inclination, deg	23.02	23.786
Difference of the right ascension of the nodes, deg	-5.30	-5.17
Central angle, deg	152.079	149.290
Transfer time, hr	3.3309	3.3340
Perigee altitude, n.mi.	141.6	130.7
Apogee altitude, n.mi.	25076.5	24917.2
First burn pitch angle, deg	9.715	14.808
First burn yaw angle, deg	23.141	20.647
Second burn pitch angle, deg	-44.204	-43.591
Second burn yaw angle, deg	-47.892	-19.058

Table 3-4. Precision Parameters of the Transfer Orbit

Parameters	Begining of Burn		End of Burn
Time from Equator Crossing, min	3.58		6.03
Argument of latitude at insertion, deg			31.60
Insertion longitude, deg	137.12W		137.24W
Inclination of transfer orbit, deg		22.98	
Difference of the right ascension of the nodes, deg		-5.255	
Transfer time, hr		3.2973 + 0.0693*	
Perigee altitude, n.mi.		143.6	
Apogee altitude, n.mi.		25220	
First burn pitch angle, deg	4.035		14.454
First burn yaw angle, deg	22.99		17.53
Second burn pitch angle, deg	-44.34		-44.09
Second burn yaw angle, deg	-47.93		-23.03

* Burn times.

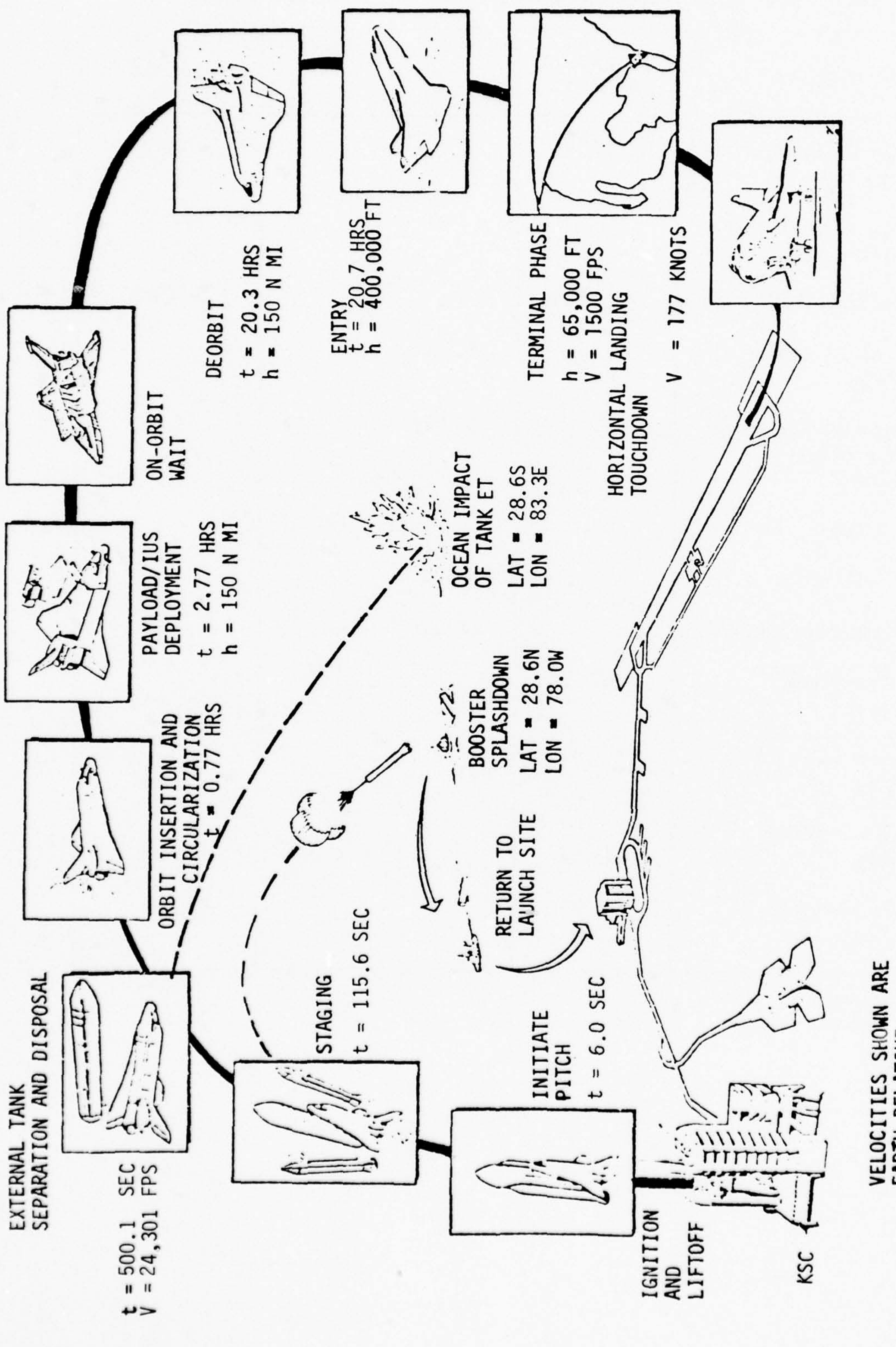
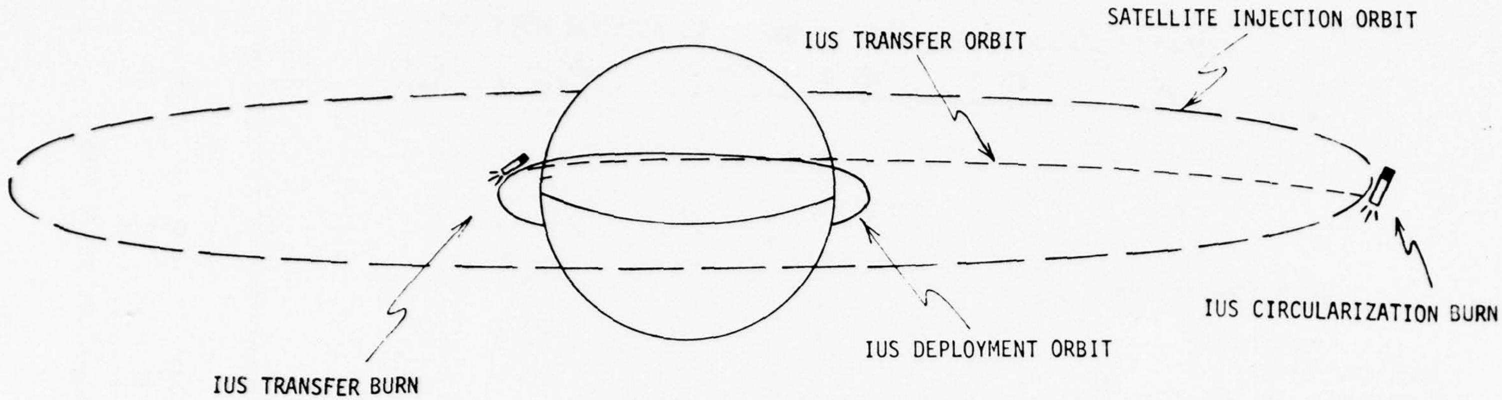


Figure 3-1. Nominal Orbiter Events



EVENT (GET)	ΔV (FT/SEC)	INITIAL PERIGEE/ APOGEE (NMI)	INITIAL INCLINATION (DEG)	FINAL PERIGEE/ APOGEE (NMI)	FINAL INCLINATION (DEG)
IUS TRANSFER BURN (5:45:06)	9079	150/150	28.5	143.6/25220	23.0
IUS CIRC BURN (9:05:24)	7952	143.6/25220	23.0	19323/19323	2.1

Figure 3-2. Nominal IUS Profile

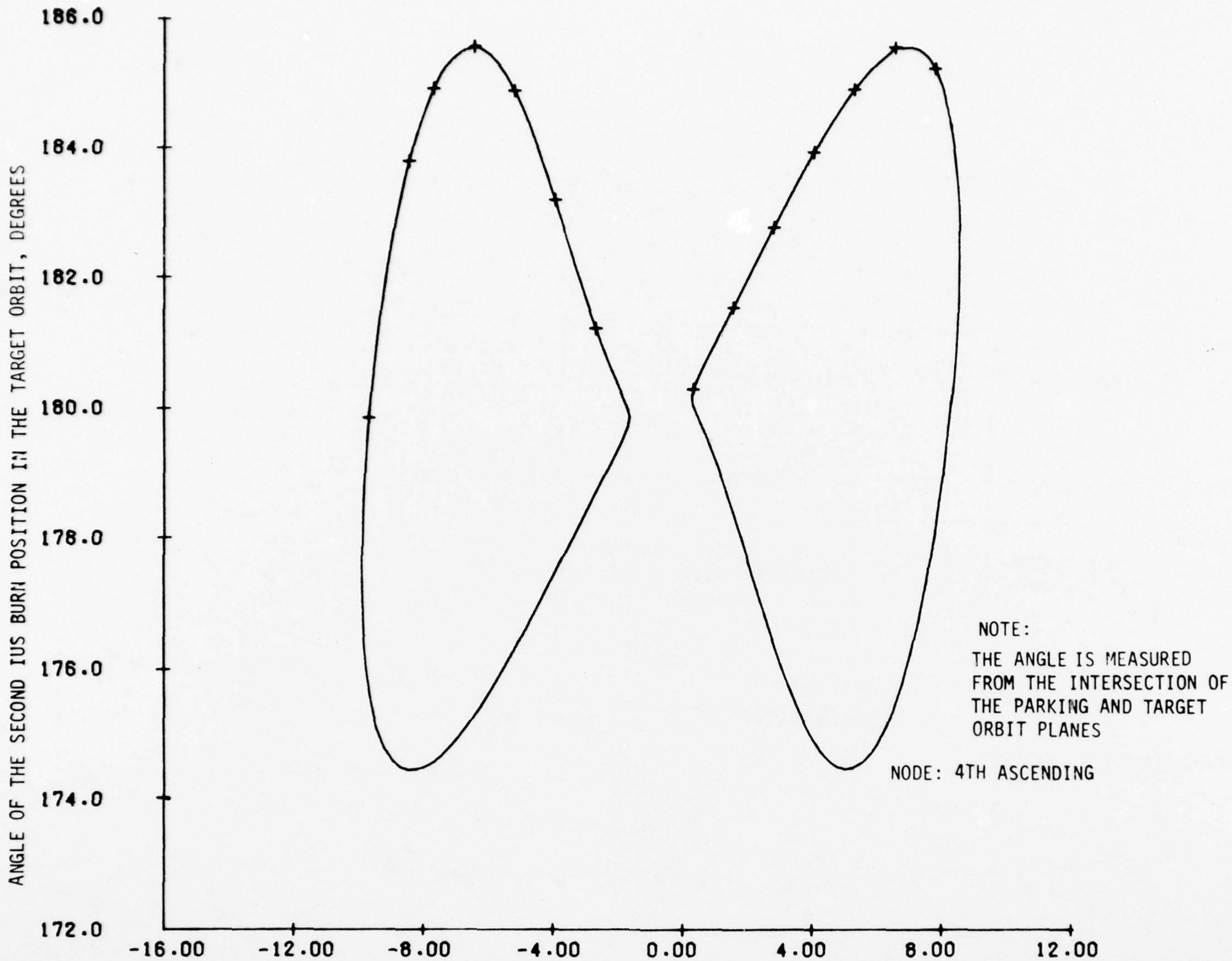


Figure 3-3. IUS Departure Window

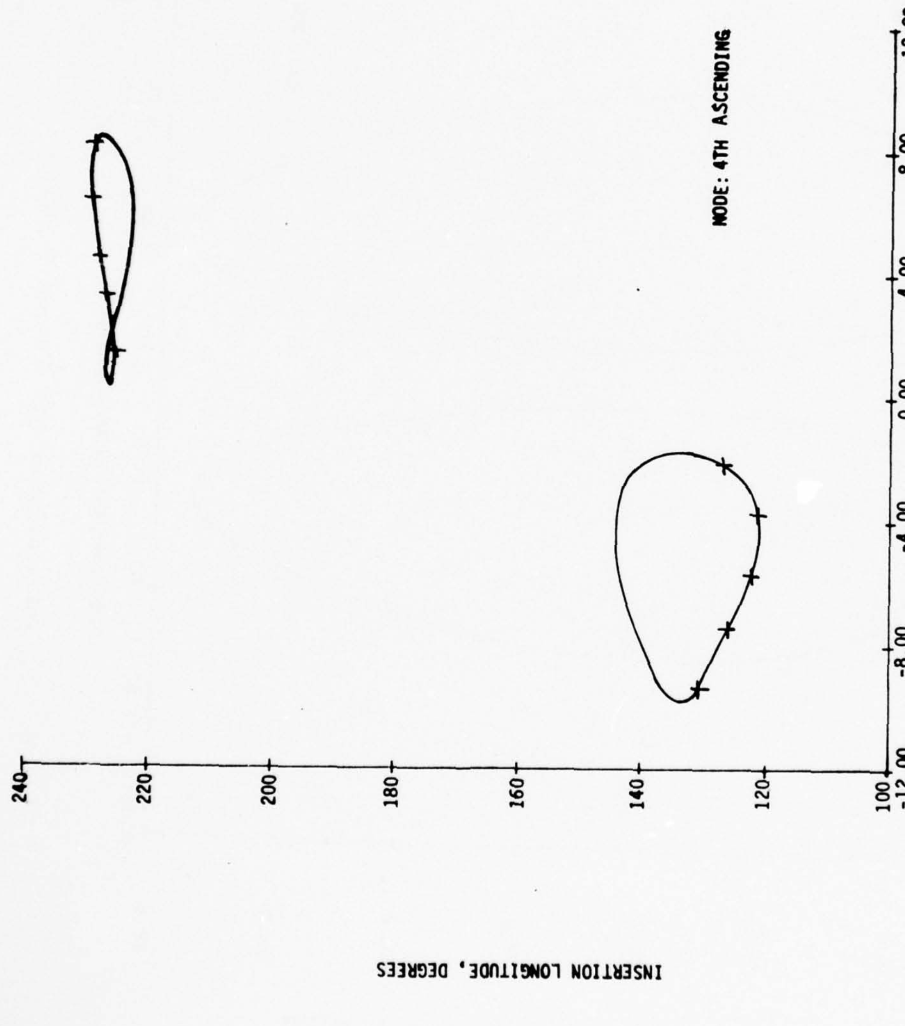


Figure 3-4. Insertion Longitude

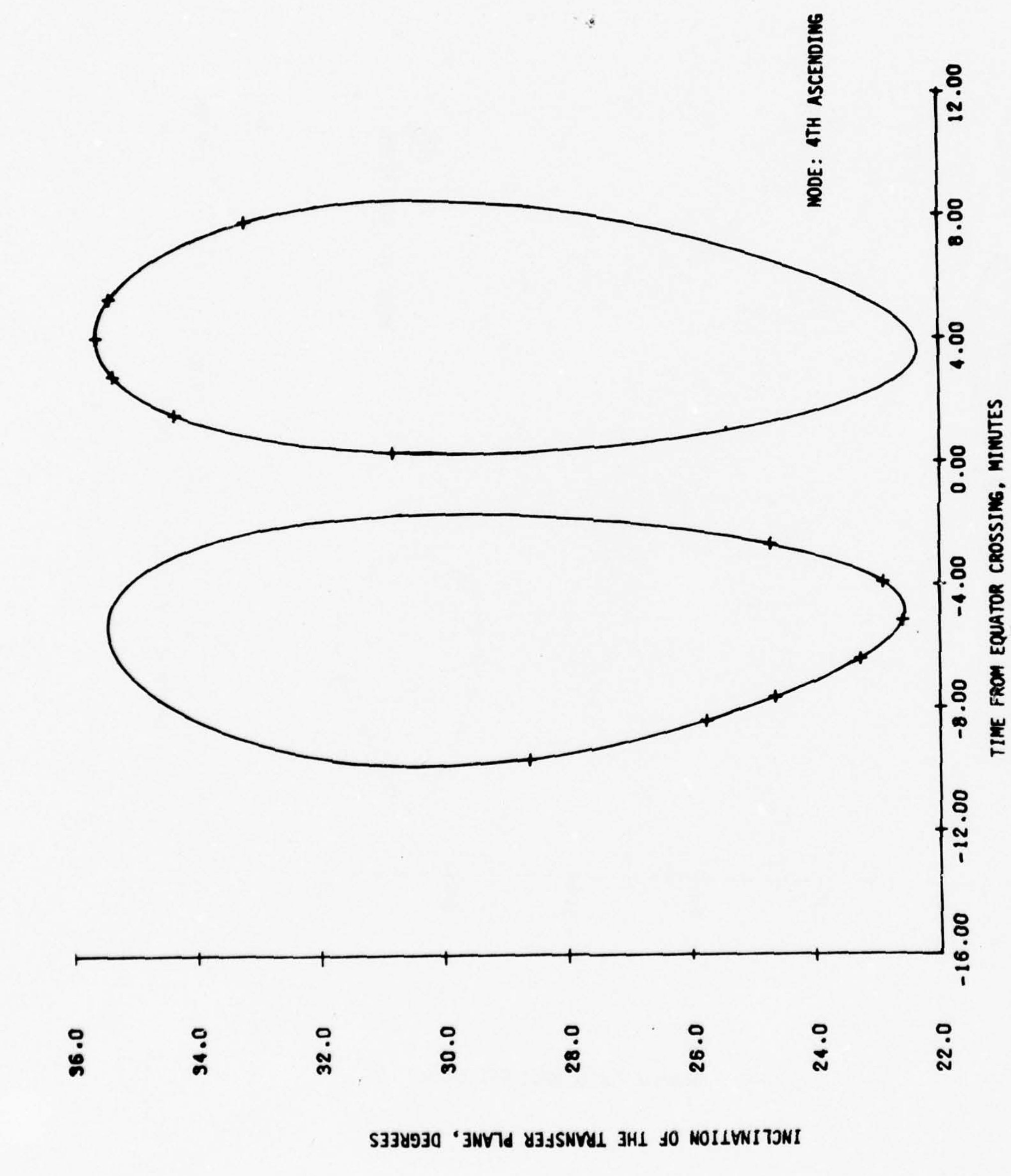


Figure 3-5. Inclination of the Transfer Plane

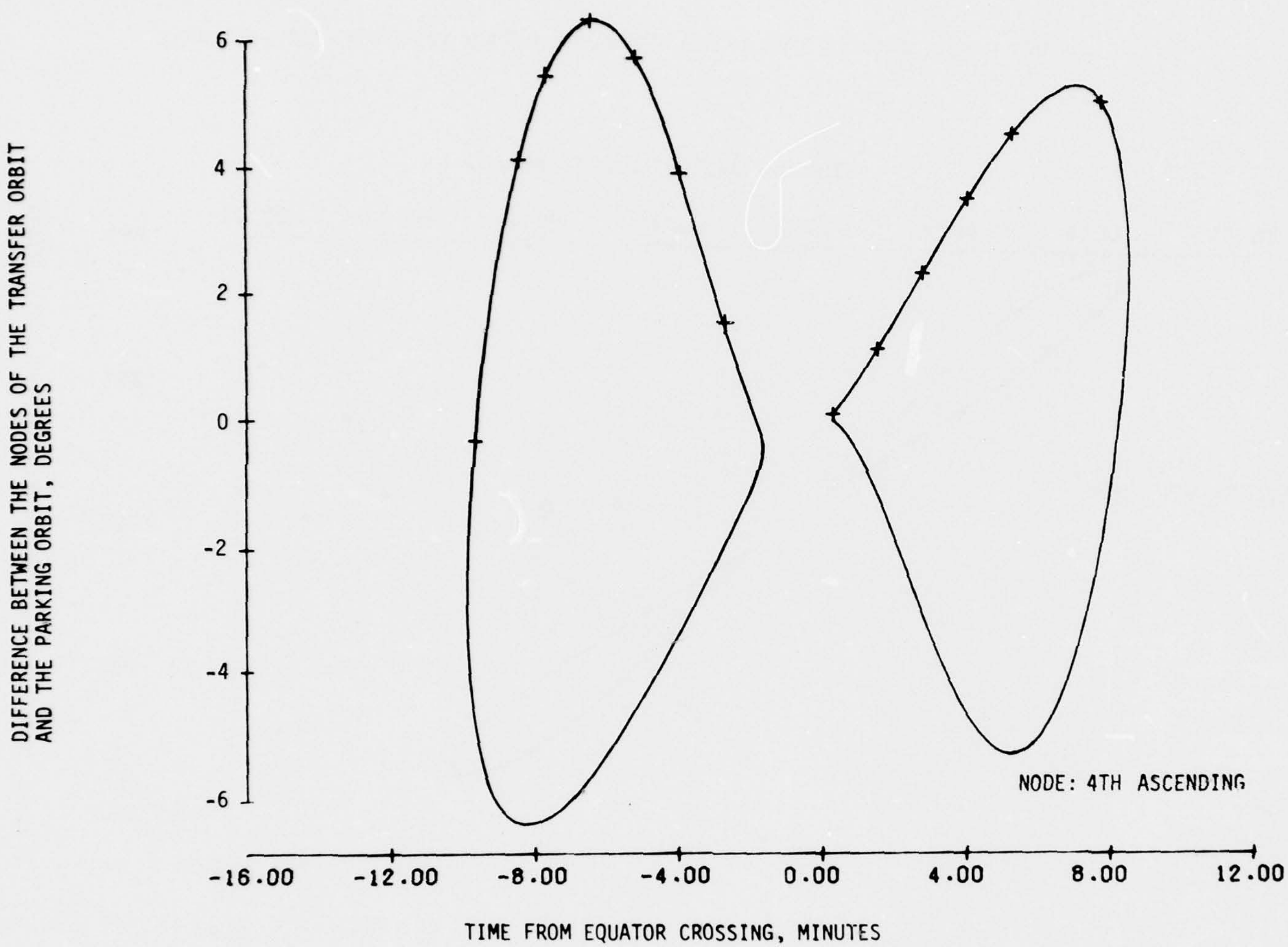


Figure 3-6. Difference Between the Nodes of the Transfer Orbit and the Parking Orbit

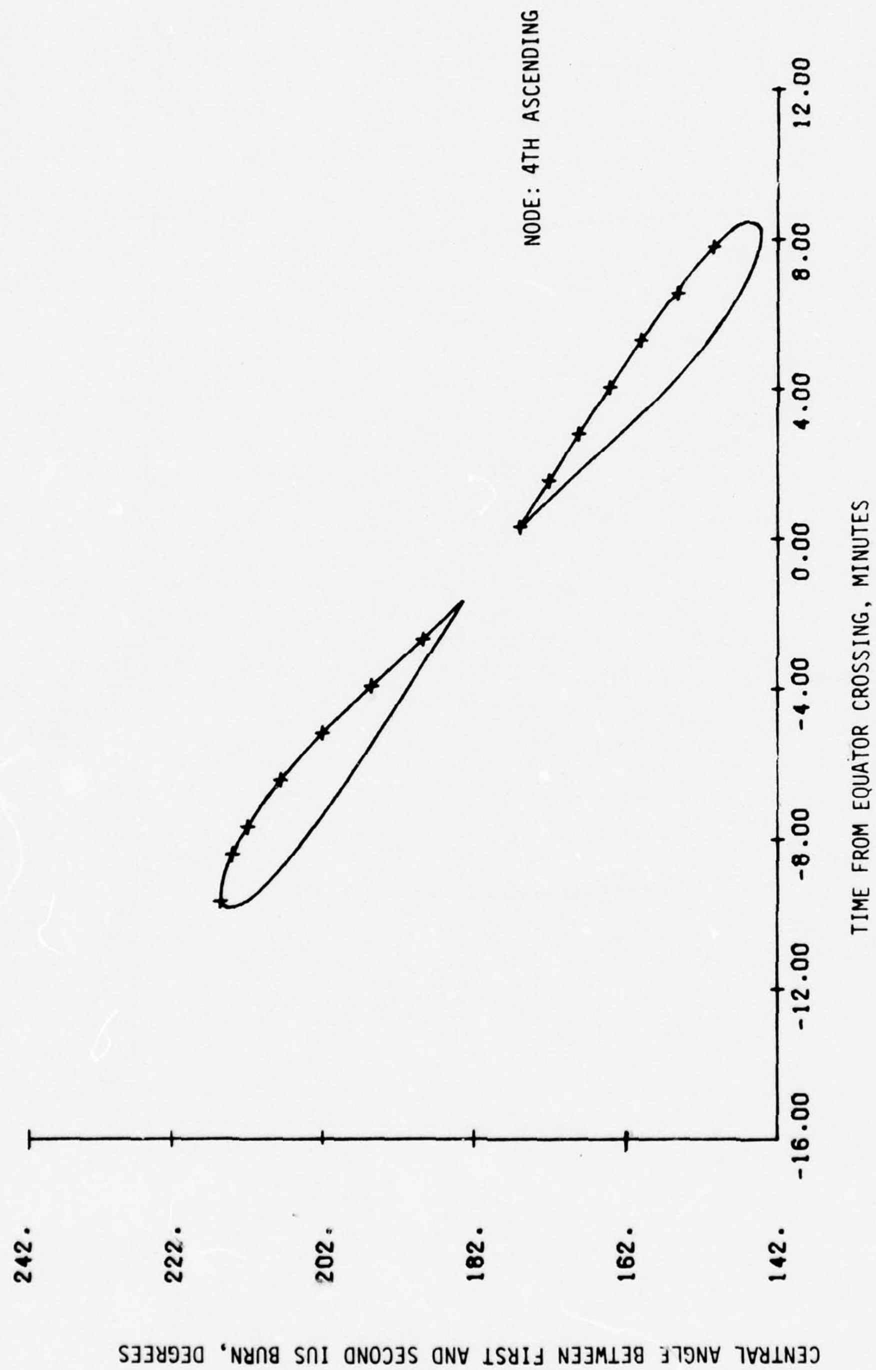


Figure 3-7. Central Angle Between First and Second IUS Burn

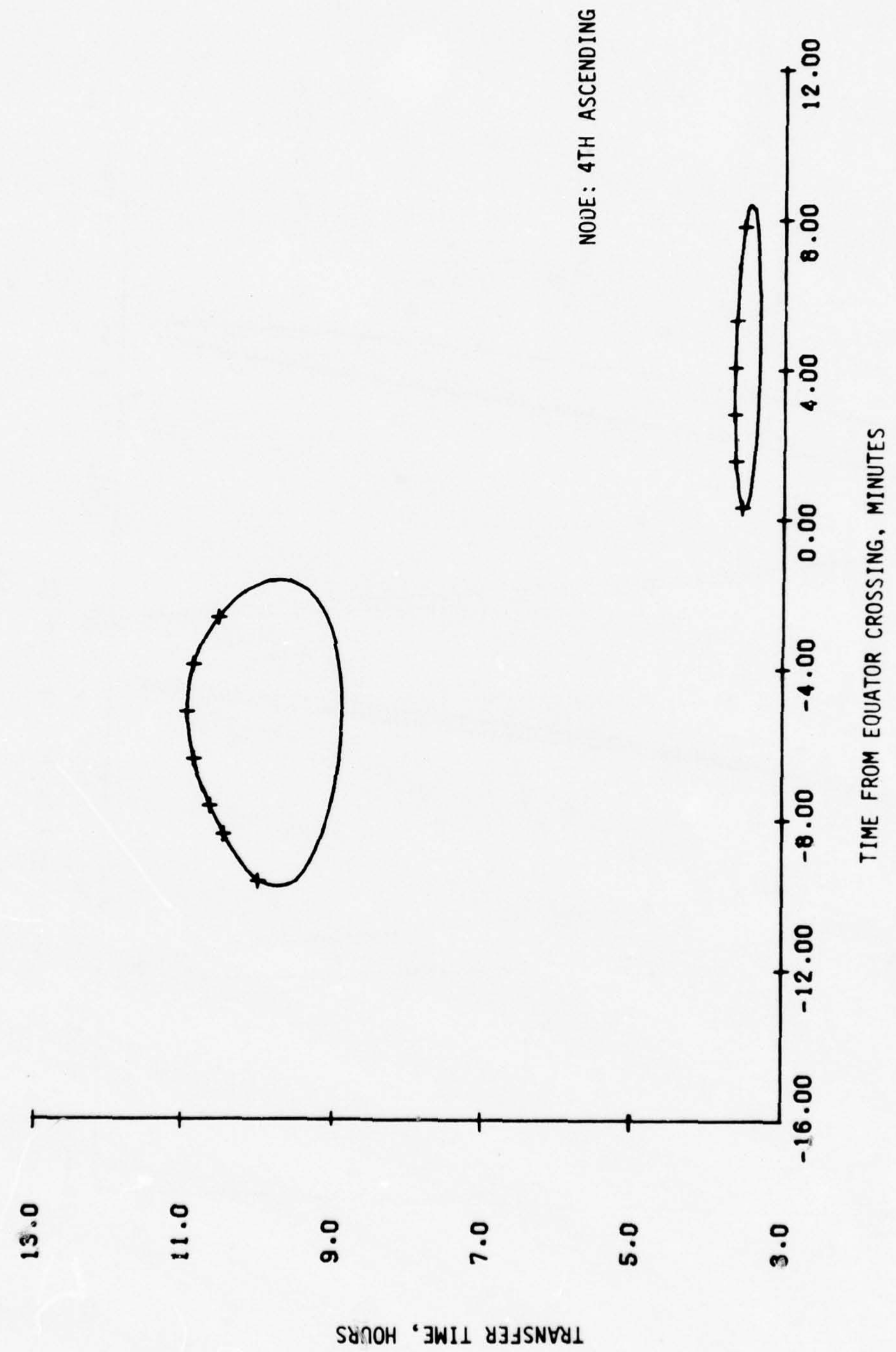


Figure 3-8. Transfer Time

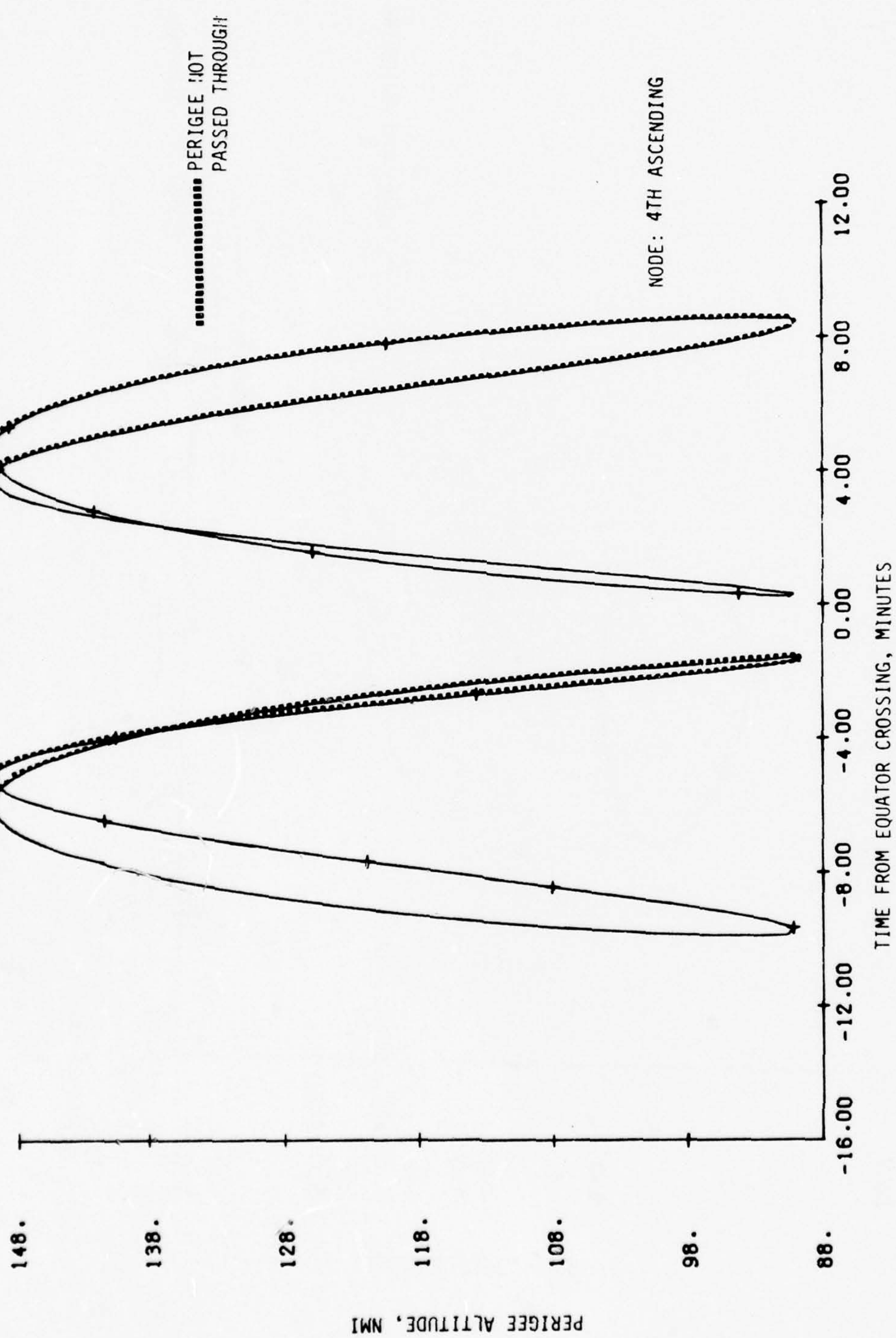


Figure 3-9. Perigee Altitude

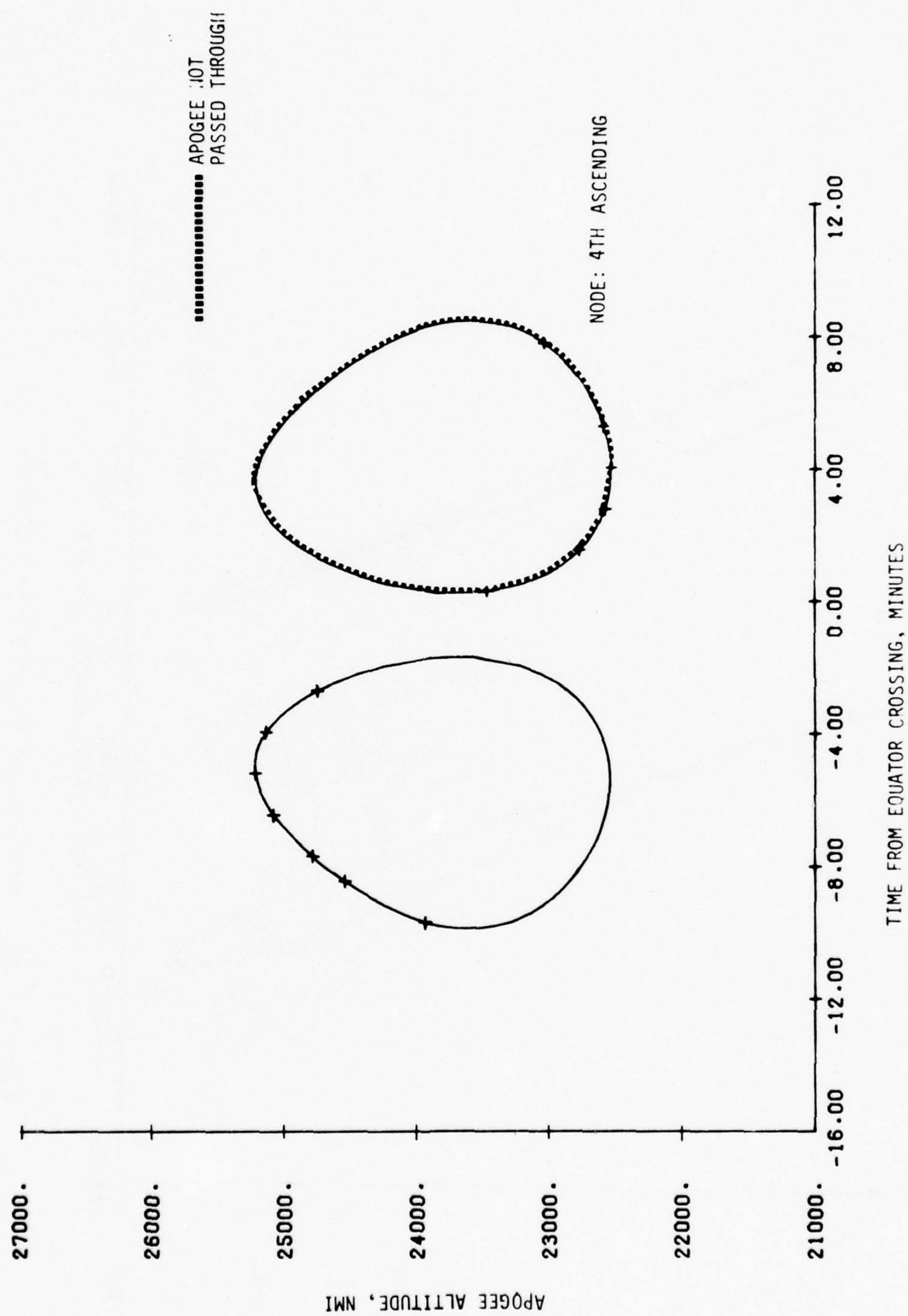


Figure 3-10. Apogee Altitude

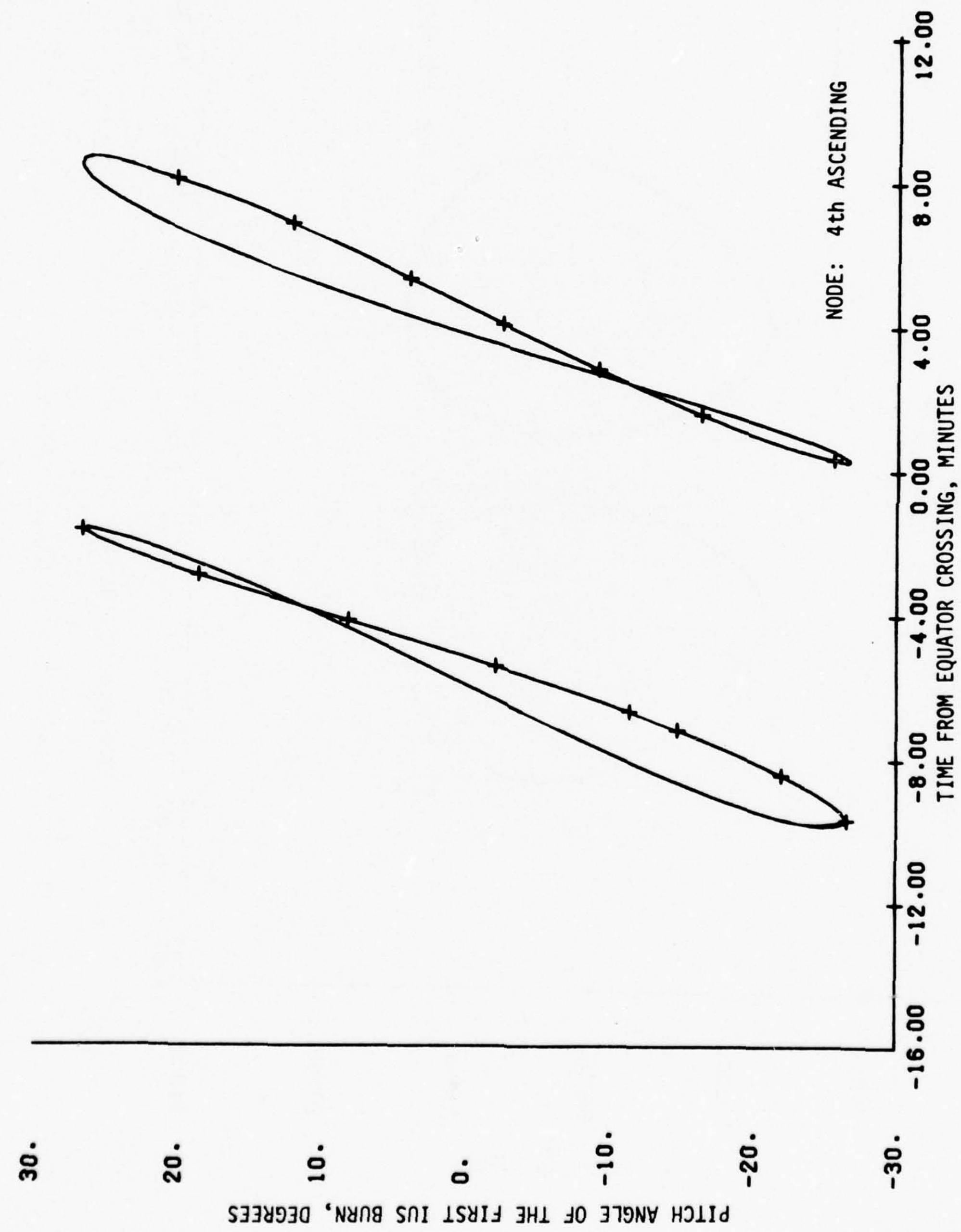


Figure 3-11. Pitch Angle of the First IUS Burn

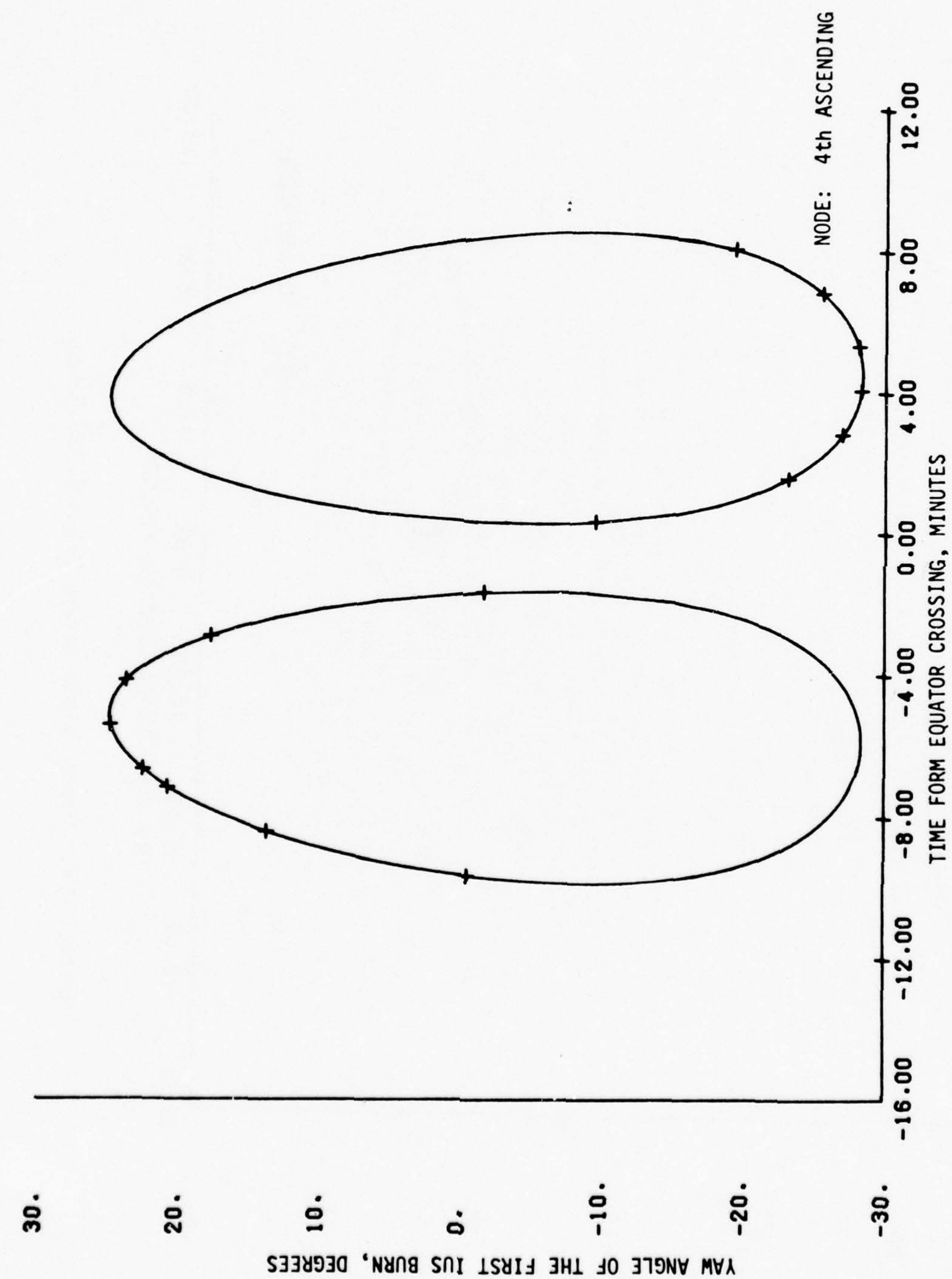


Figure 3-12. Yaw Angle of the First IUS Burn

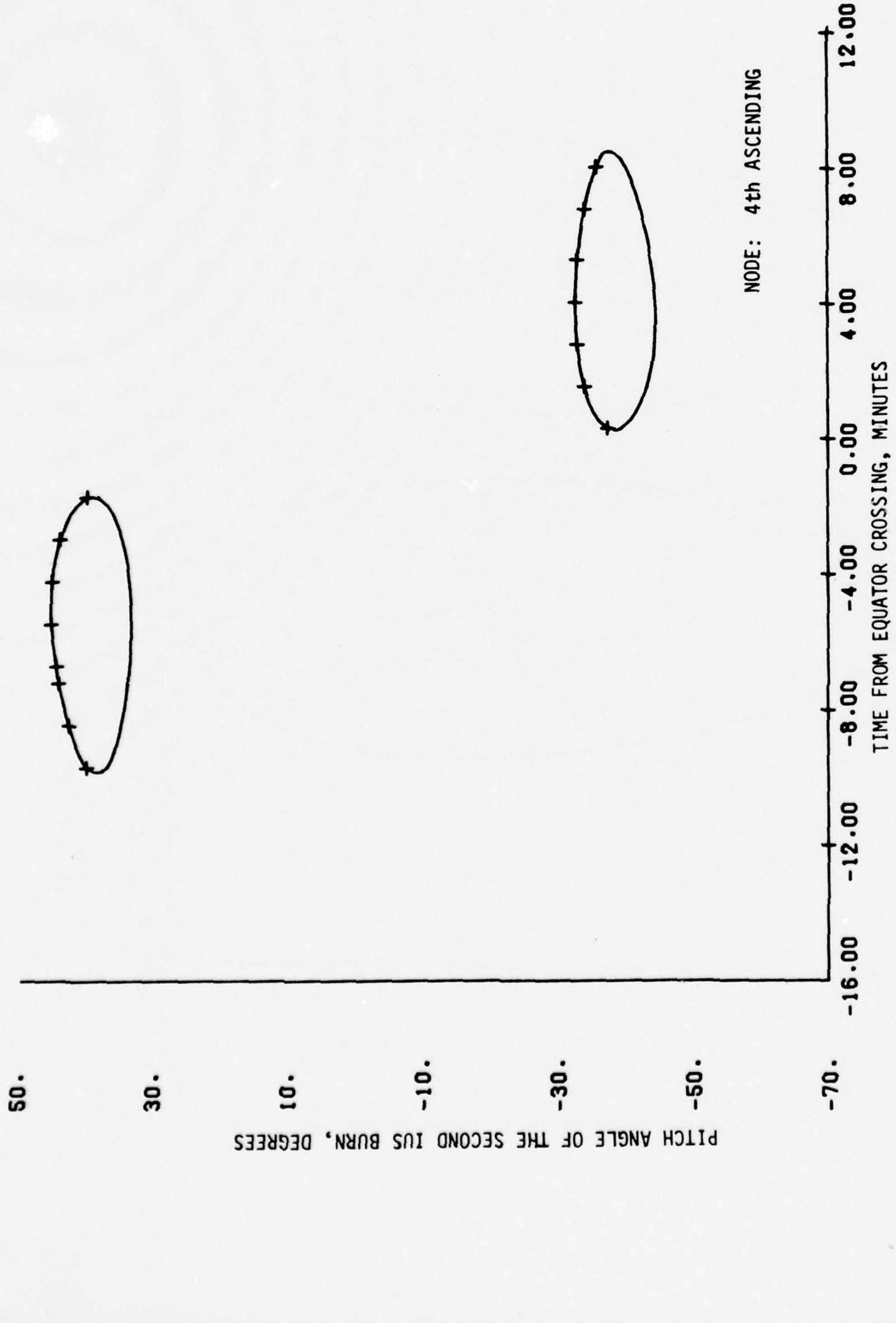


Figure 3-13. Pitch Angle of the Second IUS Burn

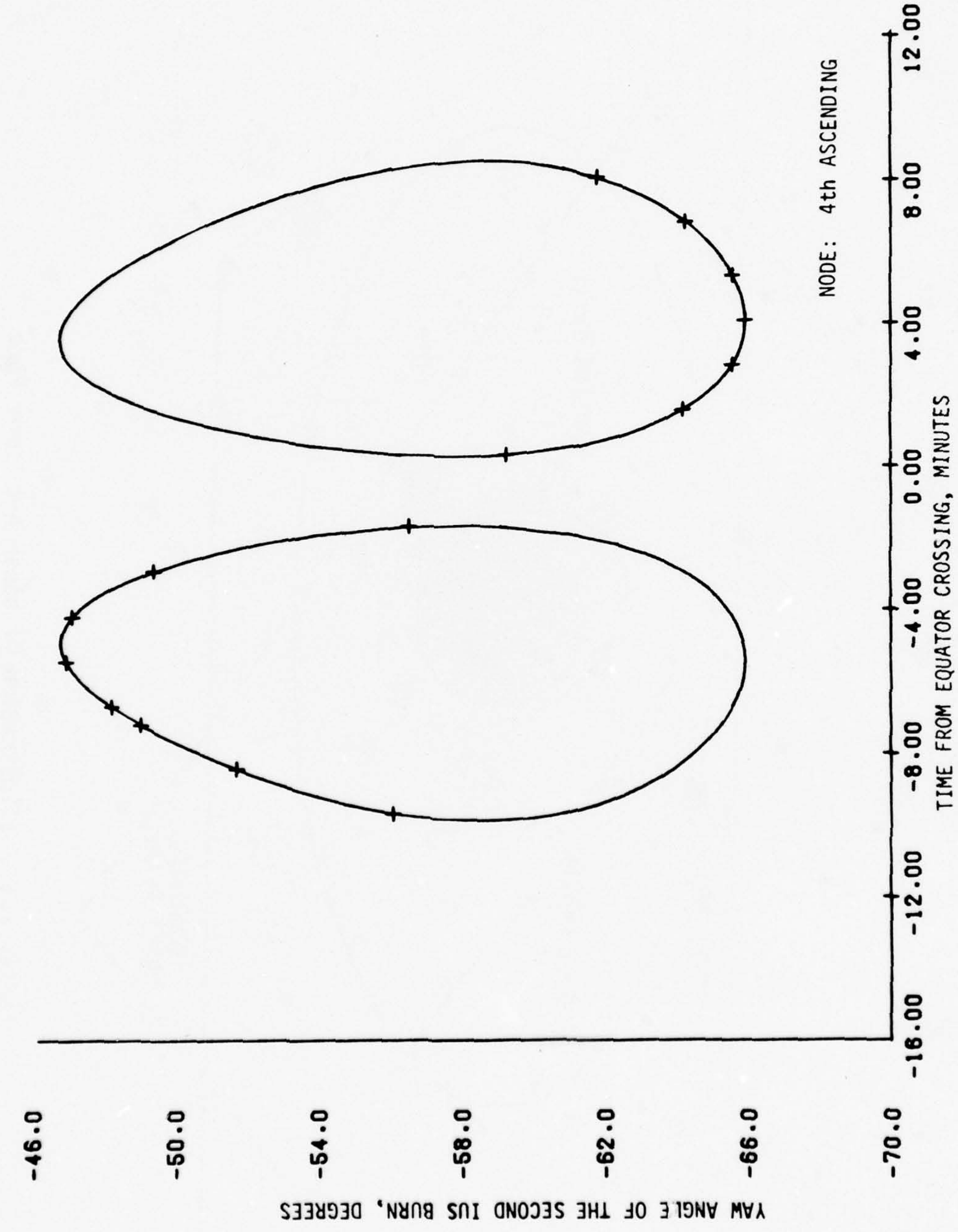


Figure 3-14. Yaw Angle of the Second IUS Burn

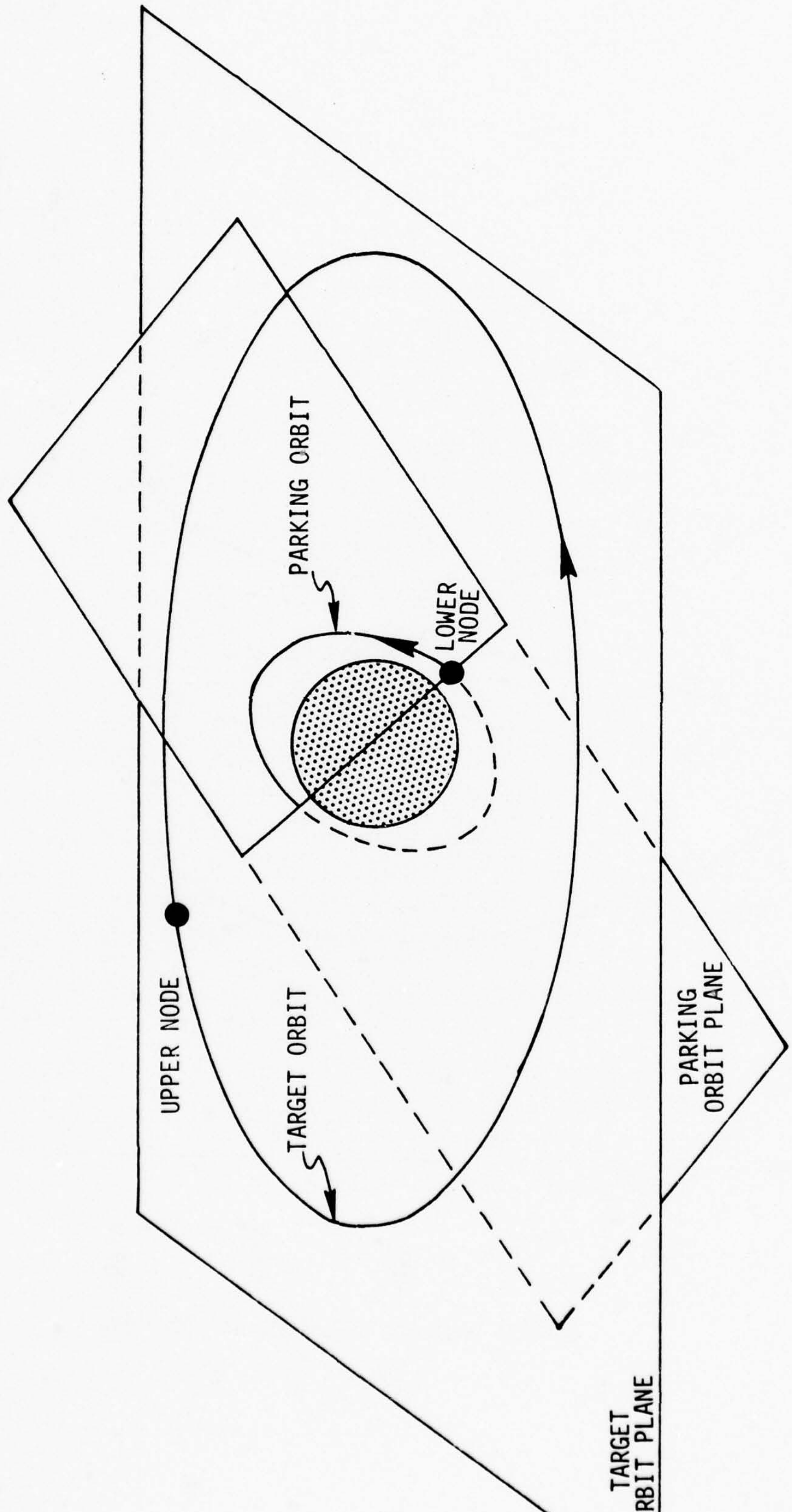


Figure 3-15. Illustration Of Upper and Lower Node

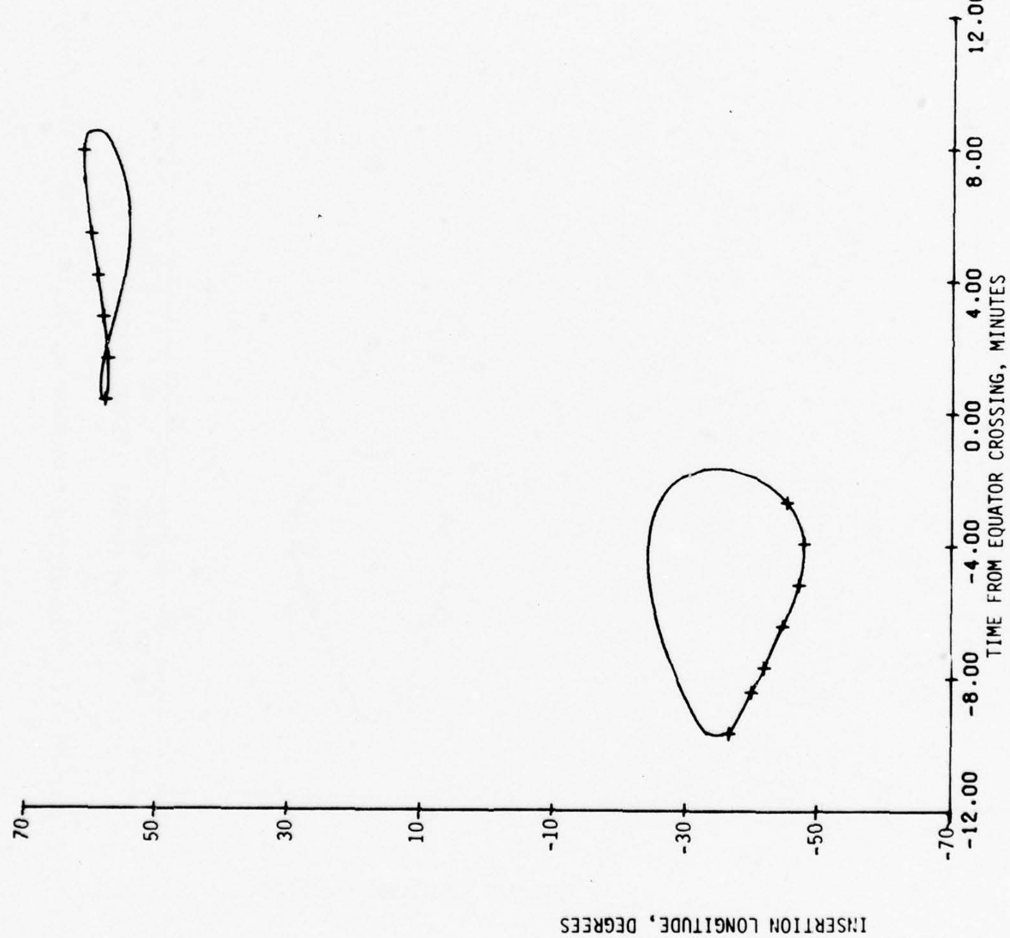


Figure 3-16. Insertion Longitude, Node: 4th Descending

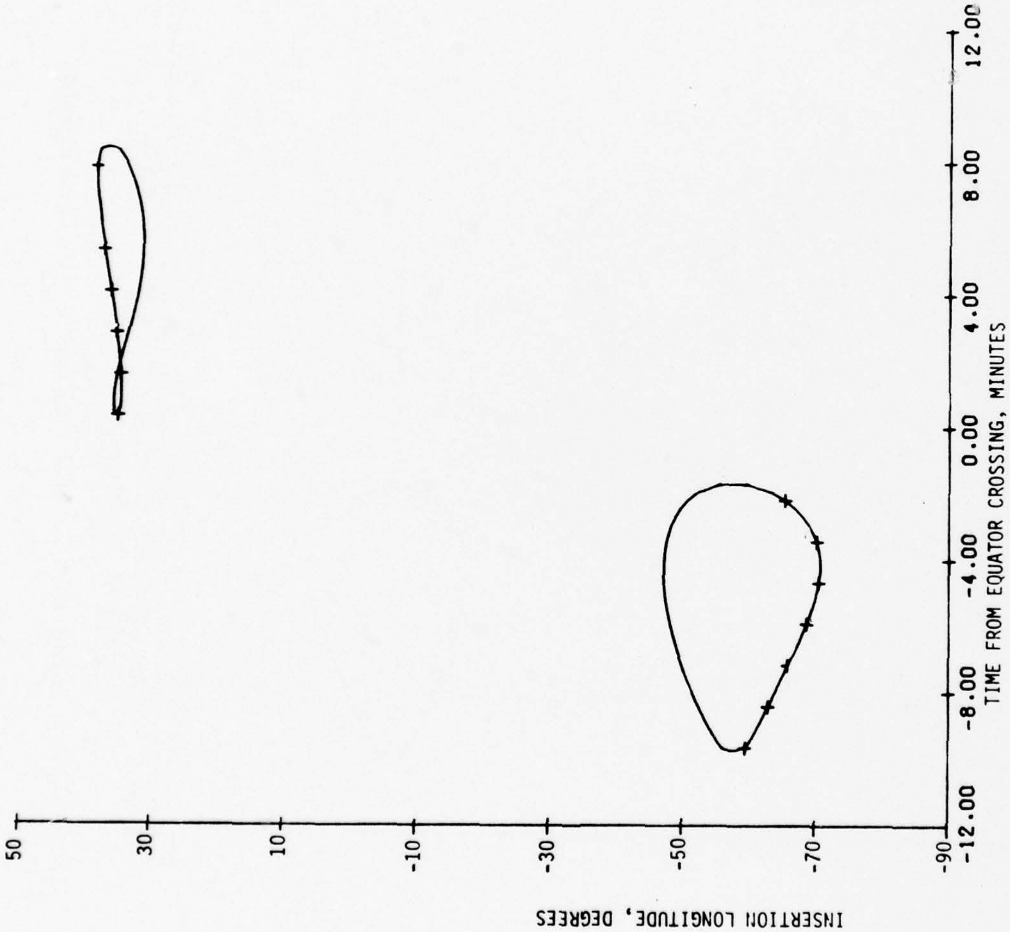


Figure 3-17. Insertion Longitude, Node: 5th Descending

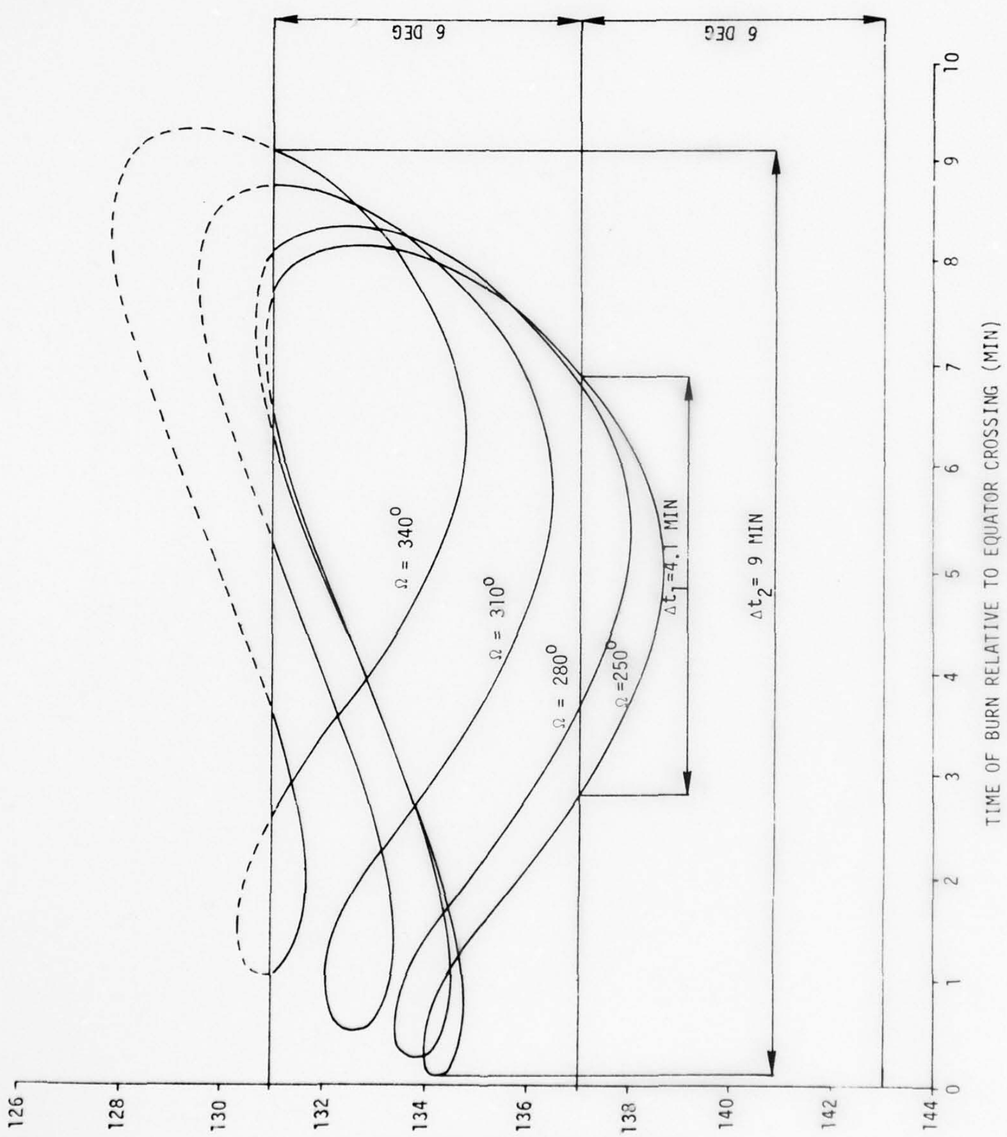


FIGURE 3-18. SHORT TRANSFER DEPARTURE WINDOWS

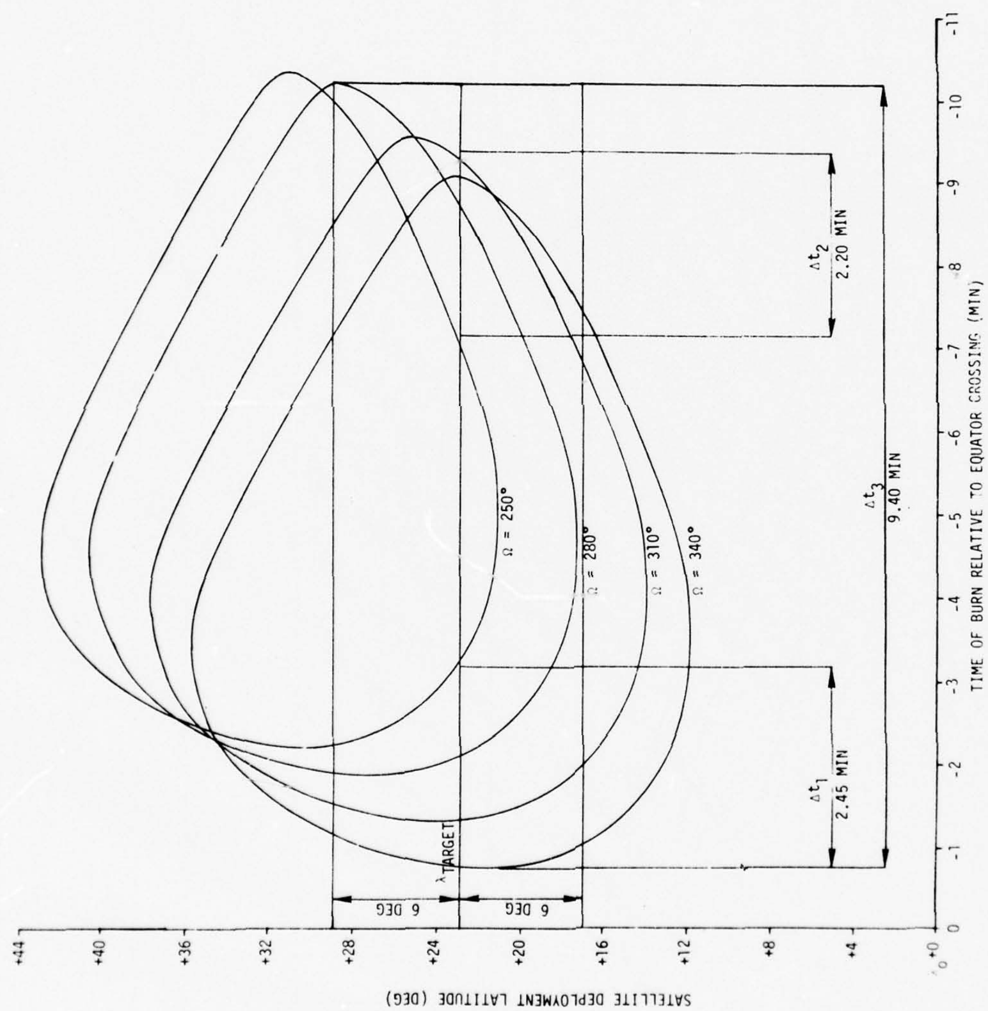
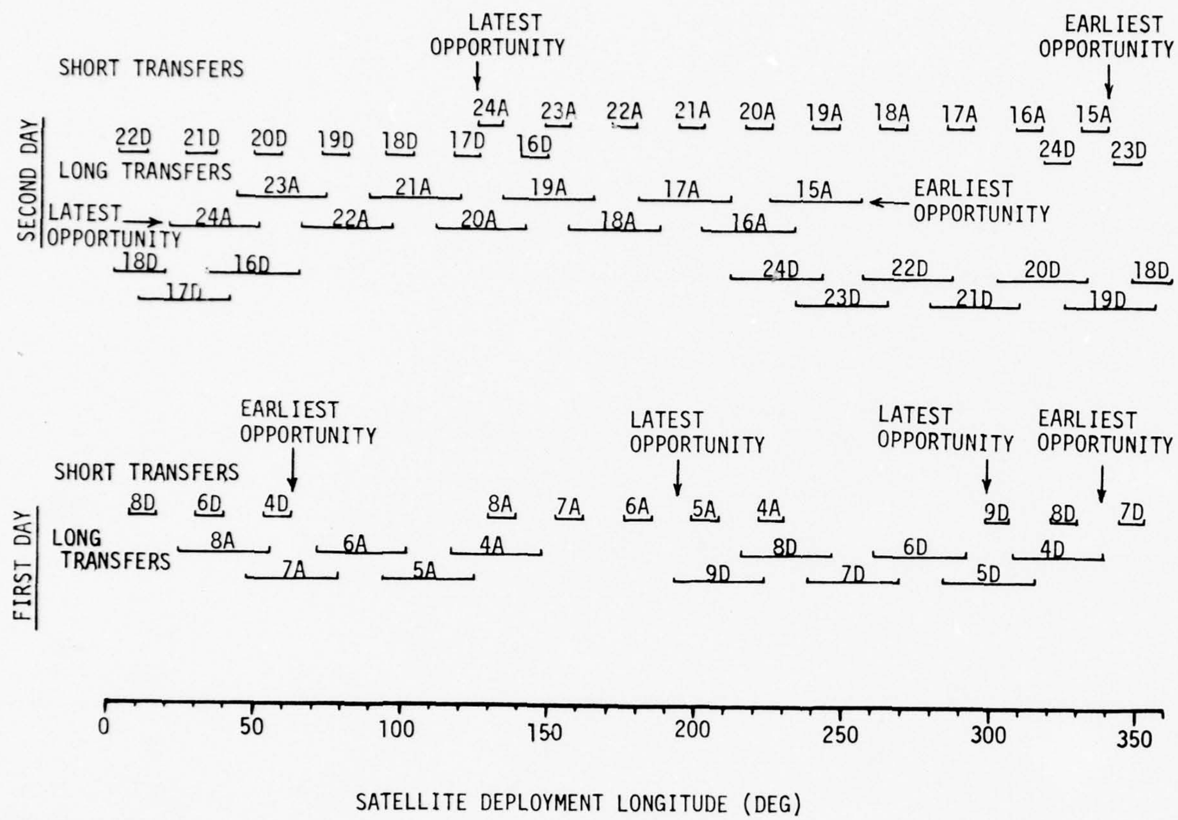


FIGURE 3-19. LONG TRANSFER DEPARTURE WINDOWS



Legend: 4A Longitudes Acessible From 4th Ascending Node
4D Longitudes Acessible From 4th Descending Node

FIGURE 3-20. ACCESSIBLE LONGITUDES DURING FIRST TWO DAYS OF MISSION

4. OPERATIONS TIMELINES AND MISSION SUPPORT REQUIREMENTS

This section presents the mission event summary and crew activity plans.

4.1 EVENT SUMMARY, OPERATIONS DESIGN MISSION A

This mission is summarized in Table 4-1. Data presented include start time and duration of each event (Δt). The velocity increment (ΔV) and resultant orbit is included for all thrust-related events.

The time durations allocated for the crew activity shown in Table 4-1 were obtained from NASA/JSC.

4.2 CREW ACTIVITY PLANS

An important part of mission design is the analysis of crew activities during the mission. This section presents the timelines for crew activities at three levels of detail.

1. Overview, (awake/rest periods, Figure 4-1)
2. Summary Timeline (major activities Figure 4-2)
3. Detailed Timeline (payload deployment, Figure 4-3)

One timeline format has been used in this report. The scale has been expanded or contracted as required for summary and detailed timelines[†].

Figure 4-1 shows an overview of Operations Design Mission A. The plan starts 10 hr before liftoff and defines the eat/rest/work cycles for the crew. The crew rest period ends 4 hr before liftoff, and the crew is awake for 16 hr. The launch and payload deployment operations require approximately 2.5 hr on the first day of the mission.

[†]An explanation of the crew activity plan format is presented in Appendix C.

Figure 4-2 presents a complete summary of Operations Design Mission A. All Orbiter and IUS engine burns are shown for the complete mission; TDRS and RTS station coverage and day/night periods are also shown.

Figure 4-3 presents a detailed Crew Activity and IUS Timeline. The following are significant payload-related features of this timeline.

- After the payload bay doors are opened, 11 min of RTS coverage are available for monitoring payload telemetry before the Orbiter IMU alignment is initiated.
- RMS activation, RMS checkout, and IUS IMU alignment (rate matching) are accomplished before attaching the RMS to the IUS.
- The attachment of the RMS to the IUS and the movement of the IUS out the payload bay are scheduled to occur during darkness.
- The IUS transmitter is turned on by the GTS and verified just prior to release of the IUS/DSP.
- The Orbiter separation burn is performed 3 min after IUS/DSP release and the IUS RCS is enabled 7 min later by the HTS.
- An Orbiter circularization burn is performed a half revolution after the separation burn.
- The IUS SRM is armed over GTS at 04:13:00 GET.
- The crew maintains visual contact with the IUS/DSP after release and until the IUS transfer burn is completed.

Table 4-2 provides explanations of selected activities.

Table 4-1. Event Summary

Major Events	Start Hr:Min:Sec G.E.T	Δt of Event/ Crew Activity Min:Sec	ΔV FPS	Resultant Orbit True Perigee n. mi.	Resultant Orbit True Apogee n. mi.
Ascent (Lift-Off: 14:50:02 GMT)					
Main Eng. Ign.	-00:00:09				
SRB Ign. Lift-Off	00:00:00				
Begin Pitchover	00:00:06				
Begin Gravity Turn	00:00:16				
SRB Shutdown	00:01:56				
Begin Constant Thrust Guidance	00:01:58				
ME Throttle-Down to 100%	00:03:55				
Begin Constant 3-G Acc. Guid.	00:07:20				
MECO (28.5° Inclination)	00:08:09			14	80
ET Separation	00:08:20				
Begin -Z Translation Burn (RCS)	00:08:20	00:05	4		
Start Insertion Burn-OMS	00:08:45	01:55	208	55	150
End Orbit Insertion Burn (OMS-1)	00:10:40				
Circularization Burn (OMS-2)	00:44:27	01:35	174	150	150
On Orbit					
Config. GPC for On-Orbit	00:50:00				
Establish Orbital Rate-Heads Down	00:53:00				
Open P/L Bay Doors	01:00:00	04:00			
Maneuver to Acquire HTS with P/L Antenna	01:05:00				
DOD-MCC Monitor P/L Telemetry via HTS	01:17:00	07:00			
Maneuver to Acquire VTS with P/L Antenna	01:24:00				
DOD-MCC Monitor P/L Telemetry via VTS	01:27:00	04:00			
Orbiter IMU Align	01:31:00	15:00			
Establish Orbital Rate-Heads Down	01:46:00				
RMS ACT & Checkout	01:46:00	15:00			
IUS IMU Alignment (Rate Matching)	02:01:00	15:00			
DOD MCC Gives GO-NO-GO for Payload Deploy	02:13:00				
Houston-MCC gives GO-NO-GO for Payload Deploy	02:13:15				
Establish Orbital Rate-Heads Down	02:16:00				

Table 4-1. Event Summary (Concluded)

Major Events	Start Hr:Min:Sec G.E.T	Δt of Event/ Crew Activity Min:Sec	ΔV FPS	Resultant Orbit	
				True Perigee, n.mi.	True Apogee, n.mi.
On Orbit (Concluded)					
Attach RMS to IUS	02:16:00	09:00			
Transfer SV to IUS	02:23:00	02:00			
Maneuver to P/L Deploy Attitude	02:25:00				
IUS to Internal Power, Final IUS C/O, Disc. IUS Elec.UMB.	02:25:00	04:00			
IUS Hold Down Release	02:29:00	04:30			
Config. Orbiter Attitude Control to Free	02:33:00				
RMS Maneuvers IUS to Deploy Position	02:33:30	09:30			
Command IUS Transmitter ON and Verify Status	02:41:00	01:00			
DOD MCC gives GO-NO-GO for IUS Release over GTS	02:42:00	00:15			
Houston MCC Relays GO-NO-GO for IUS Release	02:42:15	00:15			
Release IUS/DSP	02:43:00	00:02			
Position RMS for Sep. Burn	02:43:02	03:00			
Orbiter Sep. Burn (RCS)	02:45:57	00:08	4	150	151
RMS Stow	02:48:00	10:00			
Maneuver to Observe IUS	02:48:00				
IUS RCS ENABLE OVER HTS	02:53:00				
Maneuver to Circ. Burn Attitude	03:25:00				
Orbiter Circ. Burn	03:31:06	00:08	4	151	151
Maneuver to Observe IUS	03:22:00				
Start Crew Eat Period	03:35:00	60:00			
IUS-SRM ENABLE OVER GTS	04:14:00				
IUS Transfer Burn (4th ASCENDING NODE)	05:45:06	02:27	9079	143.6	25331
IUS Circ. Burn	09:05:24	01:42	7952	19323	19323
Orbiter IMU Align	11:17:00	15:00			
Start Crew Rest Period	12:00:00	(6 hrs)			
Crew Eat Period	18:00:00	60:00			
Orbiter IMU Align	19:50:00	15:00			
Return to Earth					
Deorbit Burn OMS (256 N.MI. CROSS RANGE)	25:01:34	02:11	297		
Entry Interface	25:26:29				
Landing at KSC (11:47:23 EST)	25:56:34				

Table 4-2. Explanation of Selected Payload Related Activities

GET	Activity
00:50:00	• ESTABLISH ORB RATE - HEADS DOWN This orbital rate maneuver is performed to keep the payload bay normally pointed toward the ground in order to keep direct sunlight from illuminating the IUS/DSP during the daylight period of the orbit. The maneuver is repeated throughout the timeline.
01:15:00	• MAN TO ACQUIRE HTS WITH P/L ANTENNA This maneuver is required to point the payload antenna at the HTS by 01:17:10 GET. This maneuver is repeated before each RTS pass.
01:17:00	• DOD-MCC MONITOR P/L TLM A requirement exists to provide 3 min of DSP telemetry data over each RTS after the payload bay doors are opened. This requirement is satisfied by the timeline.
01:30:00	• ORBITER IMU ALIGN The Orbiter IMU is aligned at this time to prepare for the IUS IMU alignment (02:01:00 GET). This Orbiter IMU alignment at 01:30:00 may not be necessary because of prelaunch alignment accuracy but is inserted in this mission assessment timeline for planning purposes in case this does become a requirement.
02:01:00	• IUS IMU ALIGNMENT (RATE MATCHING) This activity is performed at this time to schedule the RMS attachment task in darkness.
02:13:00	• DOD-MCC GO-NO-GO FOR P/L DEPLOY This is the last opportunity for the DOD-MCC to permit the deployment of the IUS/DSP and to have the decision uplinked to the Orbiter crew via MCC-H and TDRS.
02:14:00	• MCC-H GO-NO-GO FOR P/L DEPLOY This is the last opportunity for the MCC-H to permit the deployment of the RMS.
02:22:03	• TRANSFER SV TO IUS The Orbiter state vector (SV) is transferred to the IUS just prior to switching the IUS to internal power.
02:25:00	• MAN TO P/L DEPLOY ATTITUDE This is the last opportunity before IUS hold down release to maneuver the Orbiter to the attitude required for payload deployment.
02:33:00	• CONFIGURE ORB ATT TO FREE All Orbiter RCS's are inhibited at this point and the Orbiter will remain in the free attitude control mode until the Orbiter separation burn is performed.
02:41:00	• DOD-MCC CMD IUS X-MITTER ON AND VERIFY STATUS This task is performed just prior to release of the IUS from the Orbiter over GTS.
02:53:00	• DOD-MCC CMD IUS-RCS ENABLE This task is performed after the crew verifies that a safe separation distance(200 ft) has been achieved and before the DSP has been in direct sunlight for more than 14 min.
04:13:00	• DOD-MCC CMD IUS ORD AND MISSION SEQUENCE ENABLE ACCEPT IUS HANDOVER The IUS SRM is enabled after the crew verifies a safe separation distance (10 n.mi. assumed) between the IUS and the Orbiter.
05:45:06	• IUS TRANSFER BURN This burn occurs after the IUS alignment has been updated and during the fourth ascending node.
09:05:24	• IUS CIRC BURN This burn circularizes the IUS/DSP at the required geosynchronous orbit.
09:10:45	• DSP SEP FROM IUS The DSP separates from the IUS and the DSP POCC assumes control of the DSP.

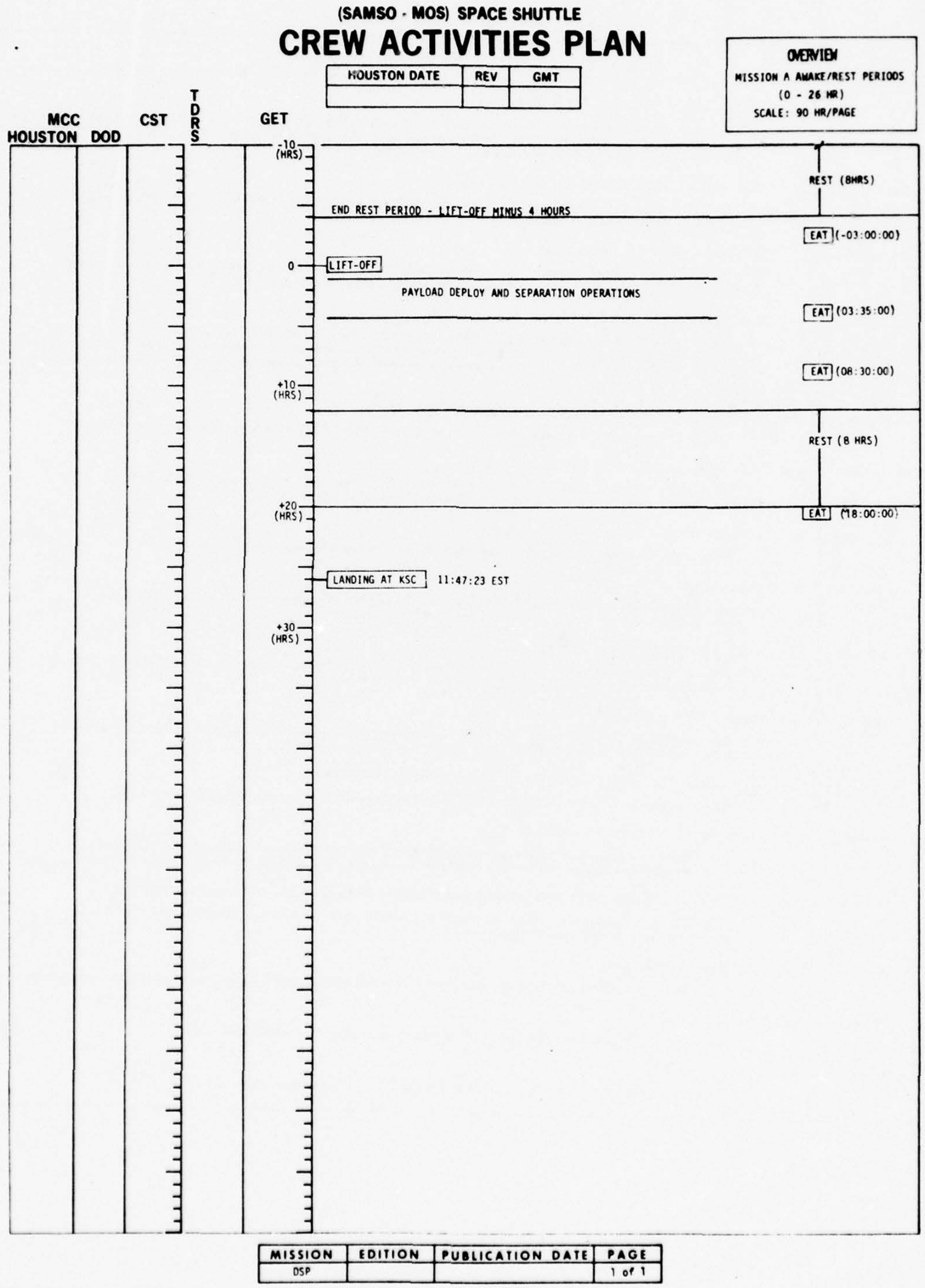


Figure 4-1. Overview

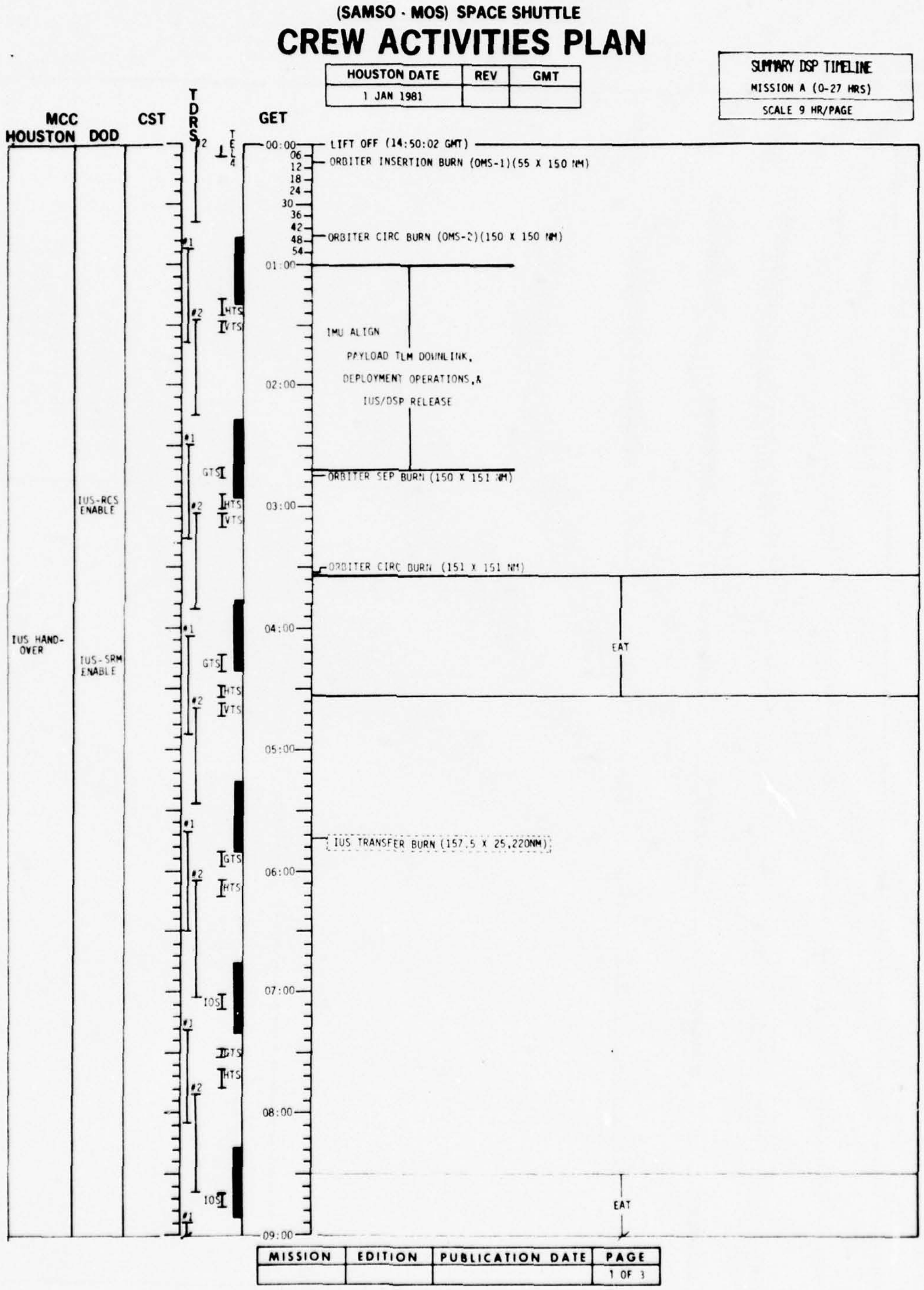


Figure 4-2. Summary DSP Timeline

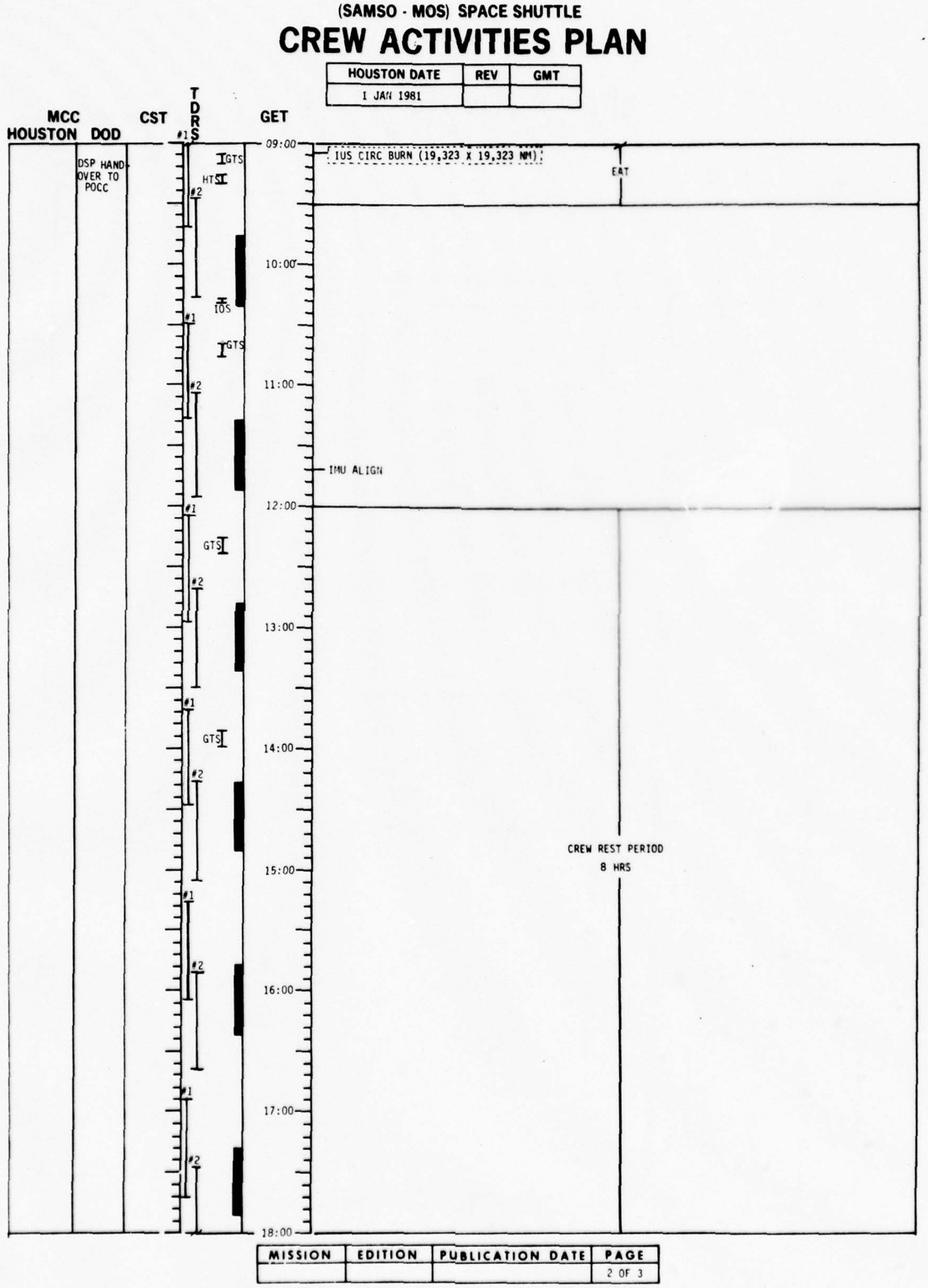


Figure 4-2. Summary DSP Timeline (Continued)

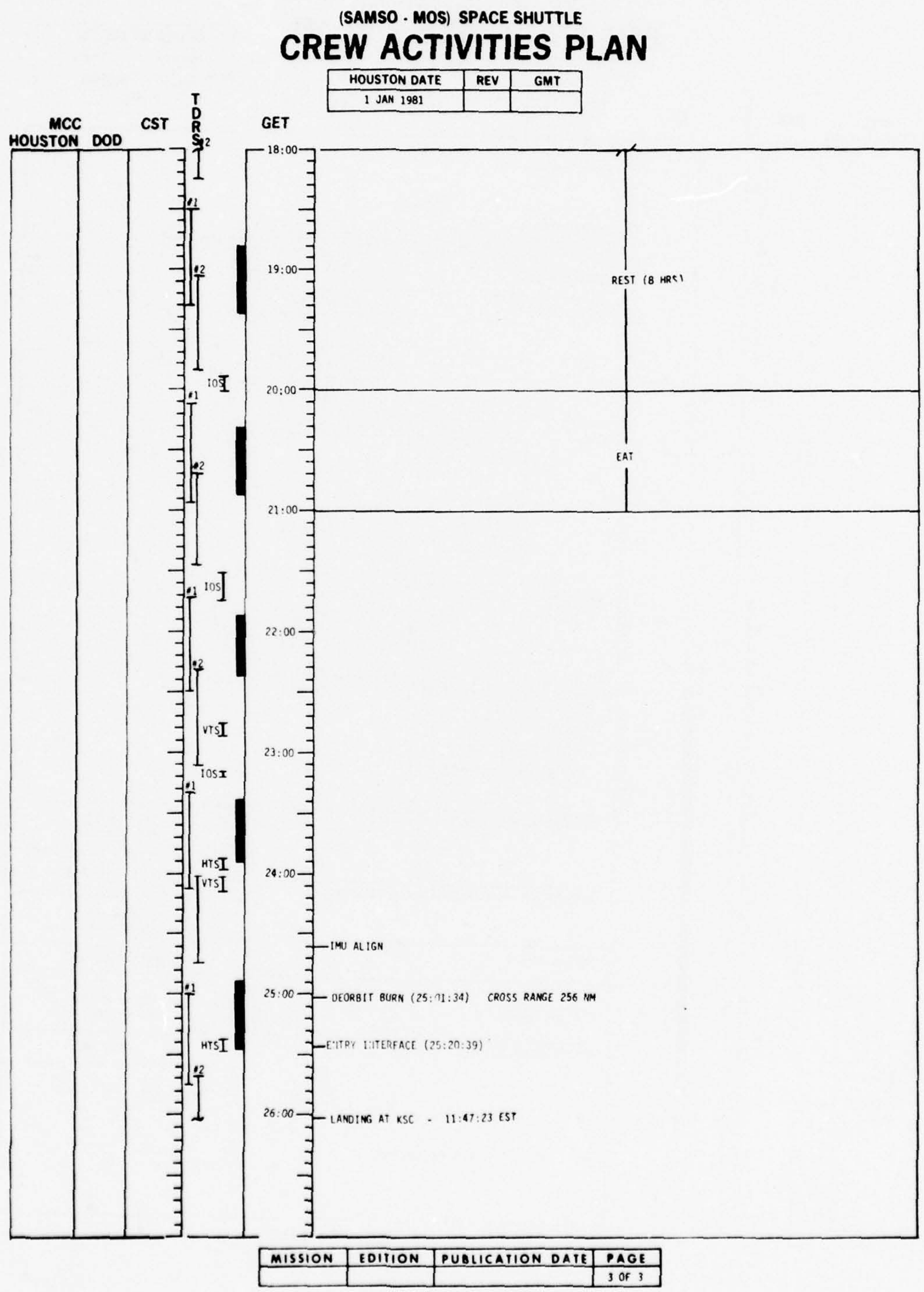


Figure 4-2. Summary DSP Timeline (Concluded)

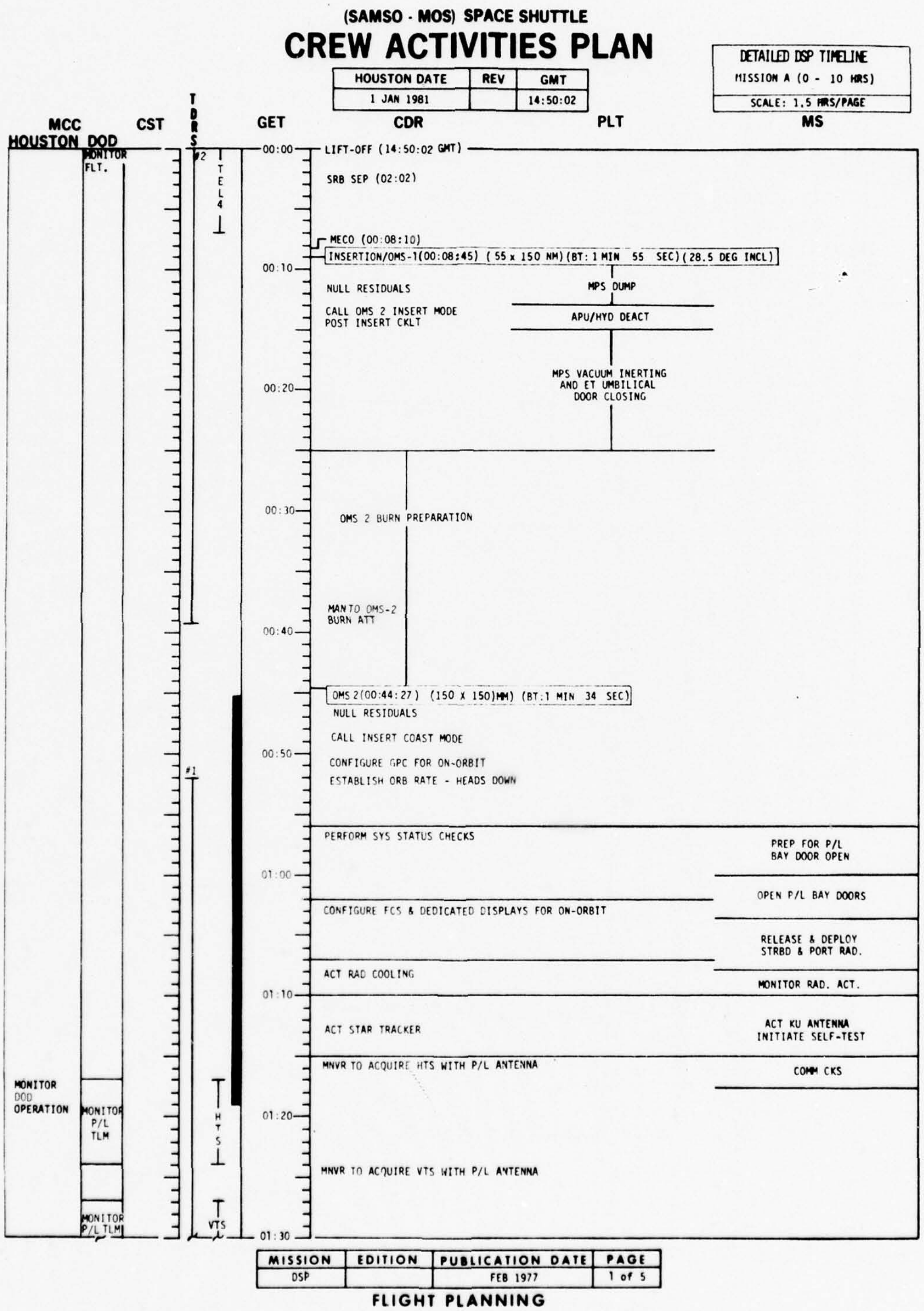
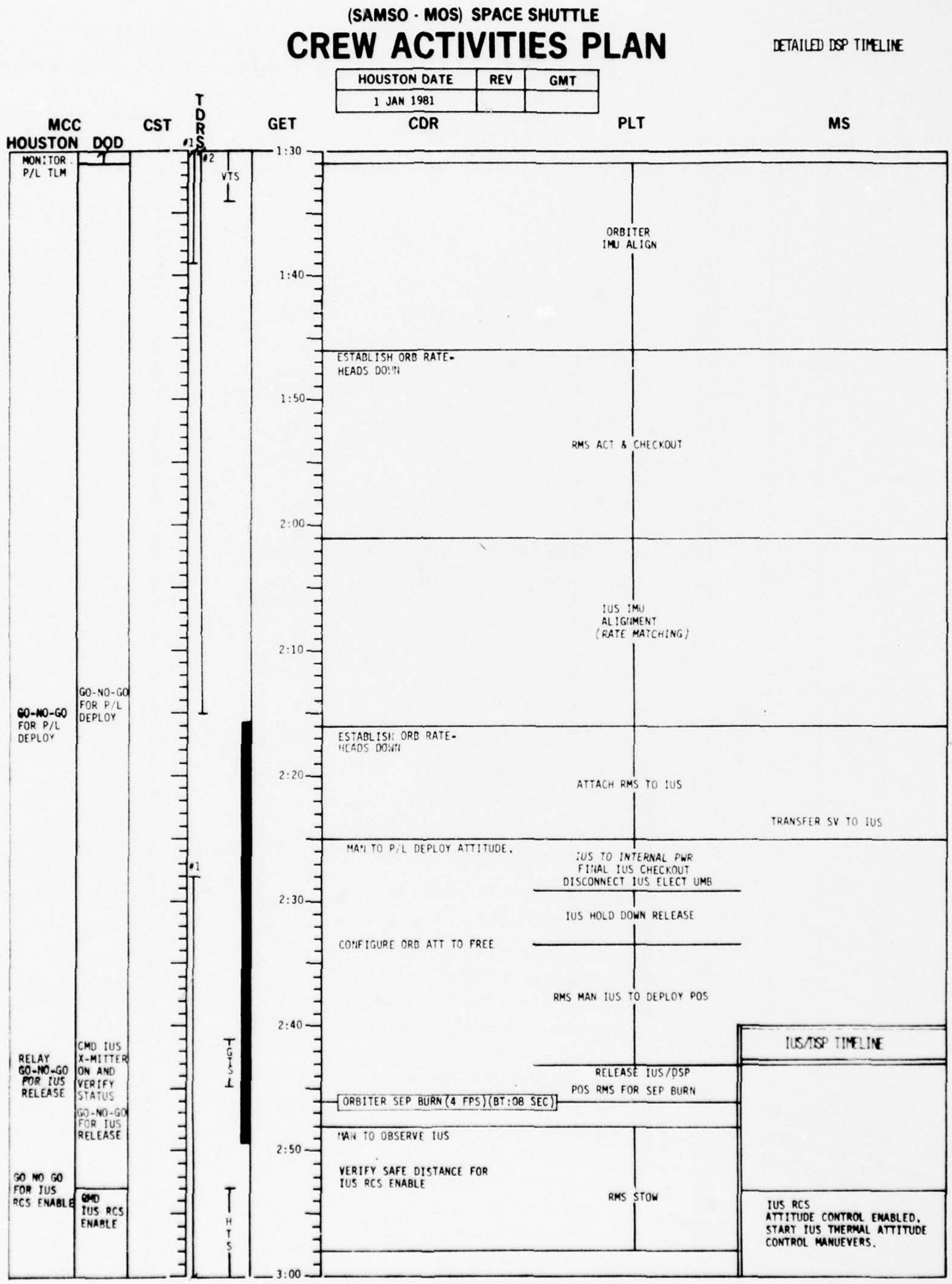


Figure 4-3. Detailed DSP Timeline



MISSION	EDITION	PUBLICATION DATE	PAGE
DSP		FEB 1977	2 of 5

Figure 4-3. Detailed DSP Timeline (Continued)

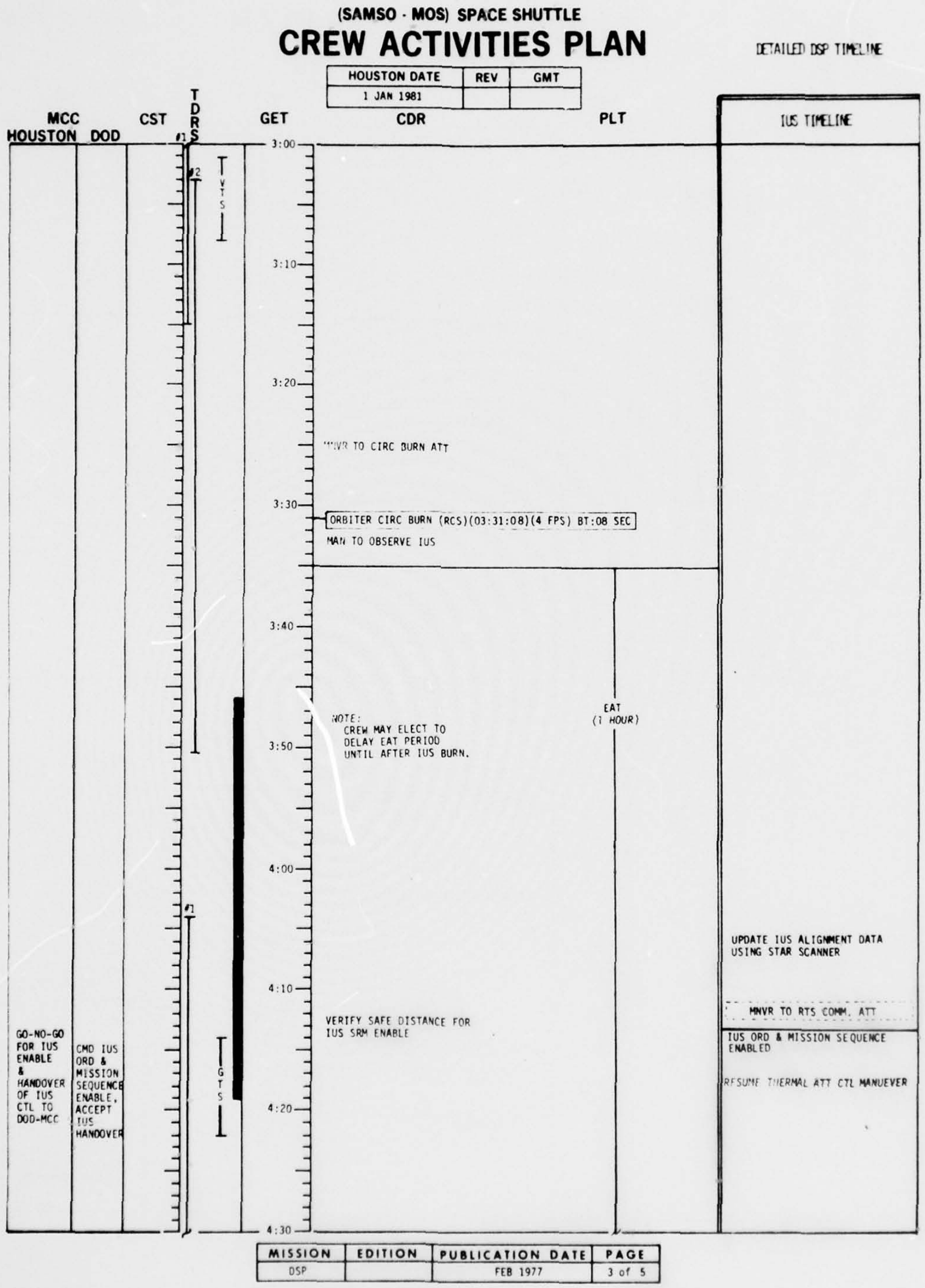


Figure 4-3. Detailed DSP Timeline (Continued)

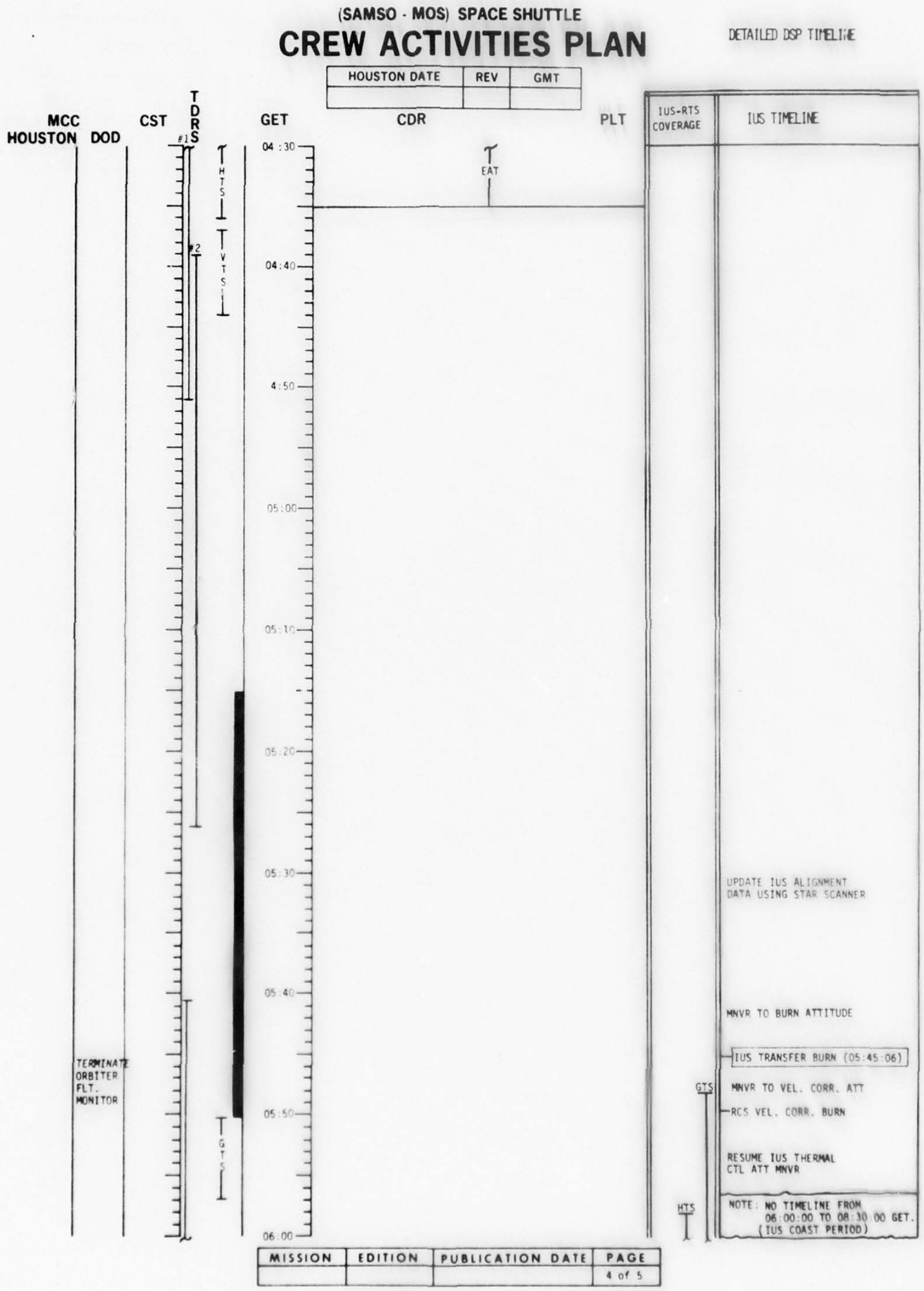


Figure 4-3. Detailed DSP Timeline (Continued)

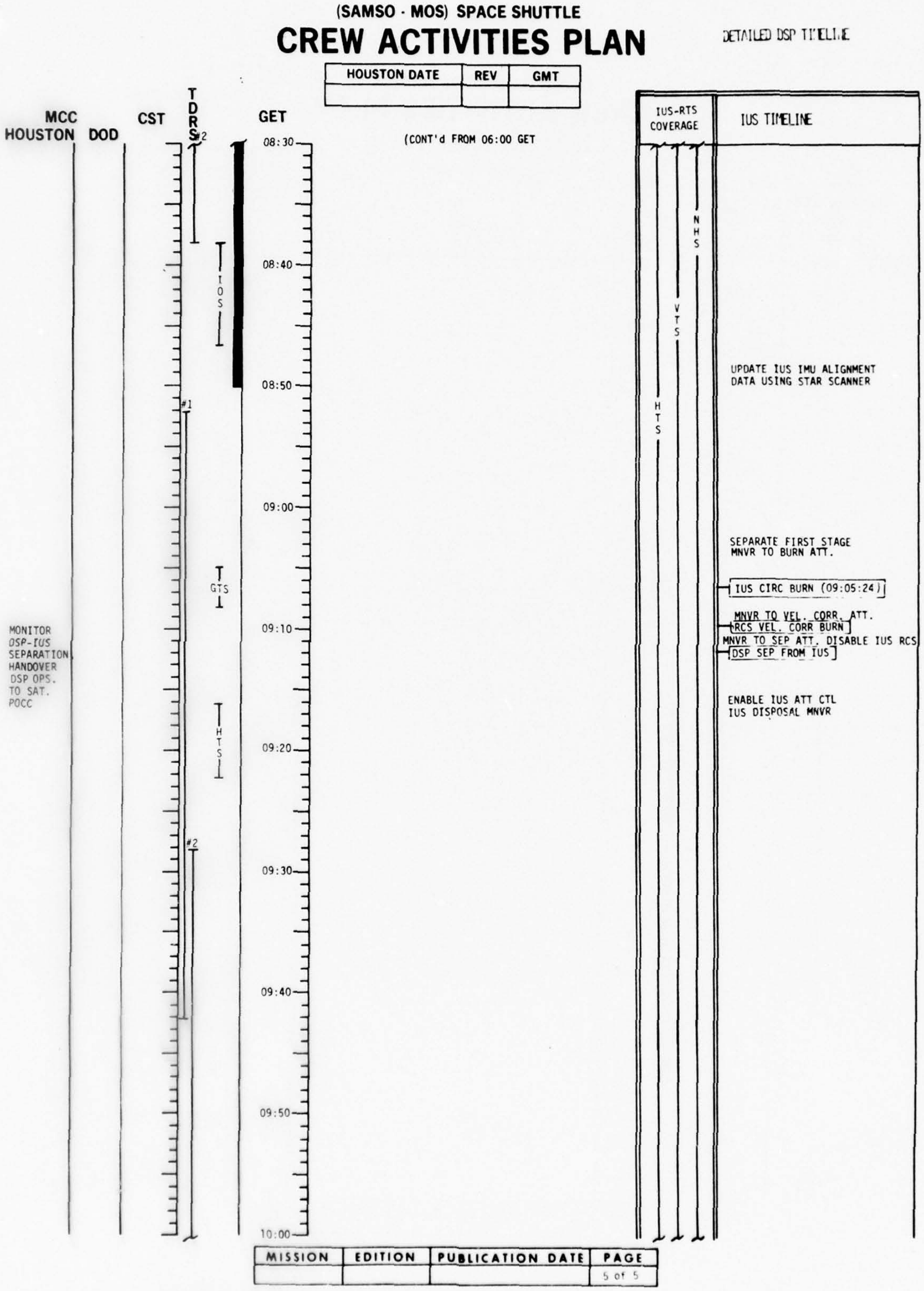


Figure 4-3. Detailed DSP Timeline (Concluded)

5. MISSION ASSESSMENT

The mission assessment activity consists of evaluating the mission design and crew activity plan to determine feasibility and adequacy.

5.1 GROUND TRACK, LIGHTING SCHEDULE AND TRACKING COVERAGE

This section describes in two parts the Orbiter and IUS trajectories as seen from the earth. The first is the projection of the orbits onto the earth map (Section 5.1.1); the second part contains tracking coverage timelines and daylight/darkness information (Section 5.1.2).

5.1.1 Ground Track Maps

The projection of the vehicle orbits onto the world map is shown in Figures 5-1 through 5-6. The coverage circles for each of the Remote Tracking Stations for an altitude of 150 n.mi. and an acquisition elevation angle of 2 deg are also shown. The ground tracks for the Orbiter and two IUS transfer burn opportunities are included. The "+" symbols on the ground track plots are spaced approximately 10 min apart.

5.1.2 Lighting and Tracking Coverage Timelines

This section presents lighting and tracking coverage parameters along a timeline (Figures 5-7 through 5-10). Each figure shows two time intervals of 2 hr 30 min. For each interval, the bottom line shows whether the vehicle is in sunlight (open) or darkness (black). Periods are also shown for remote tracking station coverage using an elevation angle of 2 deg above the horizon for the acquisition and loss of signal. In addition, the coverage from two TDRSS satellites is included with the Orbiter data. The remote tracking station facilities used in this analysis and anticipated TDRSS locations are described in Appendix A, (Section A.5).

Major events during the mission are indicated to aid in relating the schedules to the mission plan.

The data presented are for the basic mission and one alternative.

Figure	Vehicle	Transfer Node
5-7	Orbiter	
5-8	IUS	Fourth Ascending
5-9	IUS	Fifth Descending

5.2 ATTITUDE SCHEDULES

The Orbiter attitudes for the Mission A major events are summarized in Table 5-1. The gimbal angles for the boost phases are referenced to an inertially-fixed platform which is initially aligned such that the X-platform axis is parallel to the geodetic vertical and positive radially upward. The Z-platform axis is in the geodetic horizontal plane directed downrange along the launch azimuth.

Prior to payload deployment, the Orbiter is oriented to point the payload bay (-z axis) at the HTS and VTS for payload checkout. Table 5-1 shows the maneuver attitudes necessary for the RTS passes as the pitch, yaw, and roll Euler angles from the local horizontal (Appendix A, Figure A-3).

After payload release, the Orbiter performs two RCS -X (forward) translations to separate from the IUS and 45 min later recircularize the Orbiter orbit. Figure 5-11 shows the pitch attitudes during this coast period to continuously point the Orbiter -Z axis at the IUS. The pitch attitude for a -X translate is also shown.

Table 5-1 also shows the Orbiter attitudes during the OMS burns and at reentry interface for Mission A.

5.3 ORBITER CONSUMABLES ANALYSIS

An analysis of propulsive consumables required for Mission A has been performed yielding the results shown below.

Allowance	RCS, lb	OMS, lb
• Nominal	2233	13080
• Dispersion and Contingency	635	1245
• Reserves	4202	10267
• Residuals	394	564
Mission Total	7391	14889

Propellant reserves were determined by differencing the mission requirements and maximum internal tankage capability. The data show that sufficient RCS and OMS propellants can be carried on board to accomplish the mission. The dispersion and contingency allowances were developed from guidelines in Reference 10. Table 5-2 details the nominal OMS and RCS propellant required for each mission event. Tables 5-3 and 5-4 present a more detailed breakdown of the dispersion and contingency allowance as well as the allowances for residuals (i.e., trapped propellants).

5.4 ET DISPERSION ANALYSIS

The SRB and ET nominal impact points from Section 3.1 are SRB latitude, 28.6°N and longitude, 78.0°W; ET latitude, 28.6°S and longitude, 83.3°E.

NASA has conducted extensive analyses to determine the dispersion footprints of the external tank (Reference 7). The results superimposed on the nominal are shown in Figure 5-12.

5.5 CONTINGENCY/ABORT ANALYSES

5.5.1 Contingency Analysis

Analysis of the daylight/darkness and the RTS ground station coverage shows that it is possible from a mission planning viewpoint to delay the IUS/DSP deployment and release operation one earth revolution and satisfy the IUS/DSP operational constraints. For example, Figure 5-7 shows that the lighting/station pass requirements are satisfied on the revolution following the nominal deployment time. The requirements are not satisfied on subsequent revolutions. Thus, only one contingency deployment opportunity exists on the first day. This restriction could be removed by means of one or more of the following actions (Section 3.2):

- provide a full shroud on the DSP satellite to eliminate reflections and protect the spacecraft from direct sunlight
- provide an Orbiter/IUS RF link, and/or
- redefine the standard deployment orbit to provide a daily repeating ground track so that contingency deployment opportunities occur at 24-hour intervals.

In general, the desired DSP deployment longitude is not accessible using contingency opportunities. Thus, a delayed transfer burn will usually require a satellite drift maneuver to establish the desired orbital station. The maximum drift maneuver required by a one-revolution delay of the transfer burn is approximately 23 deg. Contingency transfers initiated 24 hours later than nominal from a repeating ground track orbit would not require a drift maneuver.

5.5.2 Abort from Orbit Opportunities

The deorbit opportunites to the primary landing site (KSC) and two alternate landing sites (VAFB and EAFB) have been determined for Operations Design Mission A. Periods of up to 13 hr exist during which emergency deorbit to these sites cannot be accomplished. Table 5-5 gives the abort opportunities. The coordinates used for the landing sites are given in Appendix A. The maximum allowable crossrange distance used in determining these opportunities was 1000 n.mi.

5.6 ASCENT GRAPHICAL SUPPORT DATA

Ascent profile parameters versus time are presented in Figures 5-13 through 5-21.

5.7 RELATIVE MOTION ANALYSIS

Once the P/L has been released from the Orbiter and the RMS has been retracted, the Orbiter performs a -X (forward) RCS translation (4 ft/sec) to move clear of the payload (Appendix A, Figure A-3). After this maneuver, the Orbiter coasts for 45 min during which time the Orbiter moves above and behind the IUS. Figure 5-22 shows the downrange versus radial displacement during this 45-min coast for both a +X and -X translate (4 ft/sec). Figure 5-23 shows the range during this coast period. A half revolution later (45 min after separation burn), the Orbiter performs a second -X RCS translation maneuver (4 ft/sec) to recircularize the orbit at 153 n.mi. The IUS performs its first-stage burn at 05:45:46 GET (3 hr 00 min after the P/L separation burn).

The relative motion of the IUS with respect to the orbiter during the first IUS burn has been investigated. Analysis of the relative motion is required not only to ensure that there is no collision problem, but also to identify the potential for contamination of the Orbiter with IUS exhaust products.

Figures 5-24 and 5-25 show the radial and out-of-plane relative motion trajectories during the IUS burn with the Orbiter at the origin. Figures 5-24 and 5-25 show that the IUS crosses the orbital altitude

of the Orbiter at a range of 47 n.mi. and an out-of-plane displacement of 4 n.mi. Figure 5-26 shows total range between the Orbiter and IUS throughout the first burn and demonstrates that a negative separation rate exists for the +X translate during the first 90 sec of the IUS burn, whereas the -X translate has a positive separation rate at all times.

The problem of Orbiter contamination by IUS exhaust products is beyond the scope of this analysis. Figures 5-24 and 5-28, however, provide some insight into the orientation of the IUS plume with respect to the line-of-sight to the Orbiter. Figure 5-28 shows that the angle between the exhaust vector and the line-of-sight for both the -X and +X translates decreases with increasing range from the Orbiter. The implication of this behavior requires further analysis.

5.8 ORBITER Ku-BAND COMMUNICATION

After the payload bay doors are opened, the Ku-band antenna is deployed outboard of the Orbiter moldline. In order for communication data to be transmitted to a data relay satellite (TDRS), the Ku-band signal must not be obscured by the Orbiter. The Orbiter pitch and roll look angles to the TDRS were generated with the Orbiter aligned along its velocity vector and rolled 180 degrees. Figures 5-29 and 5-30 show the Orbiter pitch and roll look angles to TDRS-189 and TDRS-319 overlayed with the right antenna obscuration zone and the combined right and left antennas obscuration zone, respectively. The Orbiter pitch and roll look angles to the two data relay satellites were also generated for the Orbiter -Z axis (payload bay) pointed at each RTS during RTS passes prior to payload deployment. Figure 5-31 shows the Orbiter pitch and roll look angles for the RTS passes overlayed with the right antenna obscuration zone. The combined right and left antennas obscuration zone is shown in Figure 5-32 for the same RTS passes.

A summary of the Ku-band antenna obscuration is shown in Figure 5-33 for the time period from the opening of the payload bay doors to deployment of the IUS/DSP. The addition of the second Ku-band antenna (left side) would provide several minutes more transmission time for Mission A. Orbiter attitude maneuvers may be required to provide TDRS communications to support the crew activity plan (Figure 4-37). These maneuvers will not present any problem with respect to RCS propellant utilization since there is a large propellant pad.

Table 5-1. Mission A Major Events Attitude Timeline

Mission Event	hr:min:sec	Gimbal Attitude, Deg			LVLH Attitude, Deg		
		Pitch	Yaw	Roll	Pitch	Yaw	Roll
• ASCENT							
SRB Ignition	00:00:00	0	0.0	90			
Begin Gravity Turn	00:00:16	-8.6	0.0	159.8			
SRB Shutdown	00:01:56	-58.0	0.0	179.4			
Reduce ME to NPL	00:03:55	-82.8	0.1	179.3			
3-G Acceleration Limit	00:07:20	-104.1	0.0	179.4			
MECO	00:08:09	-109.6	0.5	179.5			
ET Separation (4 fps, -Z)	00:08:20	-109.6	0.[illegible]	179.5			
Begin OMS Insertion Burn	00:08:45	-109.6	0.5	179.5			
OMS Insertion (~55 x 150 n.mi.)	00:10:40	-113.7	0.0	179.5			
Begin OMS Circularization Burn	00:44:27				12.7	0.0	180.0
OMS Circularization (150 x 150 n.mi.)	00:46:02				19.0	0.0	180.0
• ON ORBIT							
HTS AOS	01:17:24				65.2	0.0	226.7
HTS LOS	01:25:12				-67.0	0.0	222.5
VTS AOS	01:27:12				55.9	0.0	239.0
VTS LOS	01:34:12				-59.4	0.0	235.8
Payload Release	02:43:00						
Payload Separation Maneuver (4 ft/sec, -X forward)	02:45:57				0.0	0.0	180.0
Begin Payload Tracking	02:46:10				-20.0	0.0	180.0
Orbiter Circularization (4 ft/sec, -X forward)	03:31:05				0.0	0.0	180.0
Tracking Attitude (IUS Ignition)	**05:45:06**				**86.8**	**0.0**	**180.0**
• DEORBIT							
Begin OMS Deorbit Burn	25:01:34				24.6	180.0	0.0
End OMS Deorbit Burn	35:03:46				15.8	180.0	0.0
Reentry Interface	25:26:29				38.6	0.0	0.0

Table 5-2. RCS/OMS Propellant Usage

Event	GET	Fore	Aft(L)	Aft(R)	Total This Event	OMS
• MECO Through Insertion						
Attitude Hold After MECO	00:08:09	15	15	15	45	
ET Separation (4 ft/sec, -Z)	00:08:20	76	50	49	175	
OMS Insertion Burn (208† ft/sec)	00:08:45	--	--	--		4391
Null Residuals/MPS Dump	00:10:50	2	2	2	6	
• Circularization						
Manuever to Burn Attitude	00:42:00	16	17	10	43	
Inertial Hold	00:42:11	--	--	--		
OMS Circularization Burn (174 ft/sec)	00:44:27	--	--	--		3640
Inertial Hold	00:46:18	--	--	--		
Null Residuals (Max 5 ft/sec, +X)	00:46:20	12	70	75	157	
• P/L Checkout/Deployment						
Establish Orbital Rate	00:53:00	--	--	--		
Maneuver to Acquire HTS	01:10:00	16	17	10	43	
Maintain Orbiter Attitude	01:17:06	1	1	1	3	
Maneuver to Acquire VTS	01:25:35	16	17	10	43	
Maintain Orbiter Attitude	01:26:38	1	1	1	3	
IMU Alignment	01:31:40	7	8	4	19	
IUS IMU Alignment (Rate Matching)	02:01:00	16	17	10	43	
Maneuver to P/L Deployment Attitude	02:25:00	16	17	10	43	

†Includes MPS dump.

Table 5-2. RCS/OMS Propellant Usage (Concluded)

Event	GET	Fore	Aft(L)	Aft(R)	Total This Event	OMS
• P/L Separation						
P/L Separation Burn (4 ft/sec, -X forward)	02:45:57	7	40	42	89	
Maintain Line-of-Sight	02:46:10					
Initial Rate, 015 deg/sec		7	8	4	19	
Final Rate, 0.1 deg/sec		6	7	3	16	
Maintain to RCS Burn Attitude	03:25:00	14	15	8	37	
Orbiter Circularization (4 ft/sec, -X forward)	03:31:05	7	40	42	89	
Maneuver to IUS Line-of-Sight	05:44:00	14	15	8	37	
Maneuver to LVLH Attitude	05:48:00	14	15	8	37	
• On Orbit						
IMU Alignment	11:17:00	7	8	4	19	
Maneuver to LCLH Attitude	11:55:00	14	15	8	37	
Rest Period/Maintain Orbital Rate (6 hr)	12:00:00	4	2	2	8	
• Deorbit						
IMU Alignment	24:36:00	7	8	4	19	
Maneuver to Burn Attitude	24:57:00	14	15	8	37	
Inertial Hold	24:59:00	--	--	--		
Deorbit Burn (297 ft/sec)	25:01:34	--	--	--		5049
Maneuver to Entry Attitude	25:04:15	14	15	8	37	
Inertial Hold	25:06:10	1	1	1	3	
• Reentry						
Initial Reentry Control (Entry Interface)	25:26:29	0	563	563	1126	
• Nominal Subtotal		324	999	910	2233	13080

Table 5-3. Detailed Breakdown of OMS Propellant Allowances

Item		Allowance (lbs)
• Nominal		
• Insertion (208 ft/sec)		4391
• Circularization (174 ft/sec)		3640
• Deorbit (296 ft/sec)		5049
Nominal Total		13080
• Dispersions and Contingencies		
• Isp Variation (-3 sec)	126	
• Mixture Ratio Variation (1.91%)	250	
• Loading Accuracy (0.5%)	66	
RSS Subtotal		287
• One Failed OMS During Burn		30
• Gaging Error (1.7% full load)		425
• Velocity Errors (~24.2 ft/sec)		503
Total Dispersions and Contingencies		(1245)
• Residuals		
• Trapped in Lines		205
• Trapped in Tanks		309
• Vapor at 80°F (0.2% full load)		50
Total Residuals		(564)

Table 5-4. Detailed Breakdown of RCS Propellant Allowances

Item	Fore, lb		Aft, lb	
Nominal Total		(324)		(1909)
Dispersions and Contingencies				
• Isp Variation (1.45% fore, 2.04% aft)	5		39	
• Mixture Ration Variation (2%)	6		38	
• Loading Accuracy (0.5%)	2		10	
RSS Subtotal		8		55
• Flight Uncertainty (5%)		16		95
• $+3\sigma$ Inflight Gaging Error (5.4% full load)		125		252
• One Failed OMS During Burn		0		84
Total Dispersion and Contingencies		(149)		(486)
Residuals				
• Trapped in Lines		57		186
• Trapped in Tanks		45		91
• Vapors at 80^{o} F (0.2% full load)		5		10
Total Residuals		(107)		(287)

Table 5-5. Abort-From-Orbit Opportunities

Time of Ignition hr:min:sec	Landing Site	Delta-V, ft/sec	Crossrange Distance, n.mi.	Local Landing Time, hr:min:sec
00:50:39	VAFB	293	418	8:35:08
00:51:13	EAFB	294	412	8:35:43
00:59:34	KSC	298	139	11:44:10
02:25:26	VAFB	296	374	10:10:02
02:26:01	EAFB	297	397	10:10:37
02:34:45	KSC	299	514	13:19:15
04:00:13	VAFB	300	569	11:45:15
04:00:49	EAFB	300	618	11:45:49
05:35:25	VAFB	299	978	13:20:11
18:41:30	KSC	300	783	05:26:11
20:16:29	KSC	298	307	07:01:13
21:51:27	KSC	298	38	8:36:29
23:17:57	VAFB	300	562	7:03:17
23:18:31	EAFB	300	539	7:03:52
23:26:52	KSC	300	19	10:12:01
24:53:09	VAFB	299	371	8:38:15
25:01:34	KSC	297	256	11:47:23

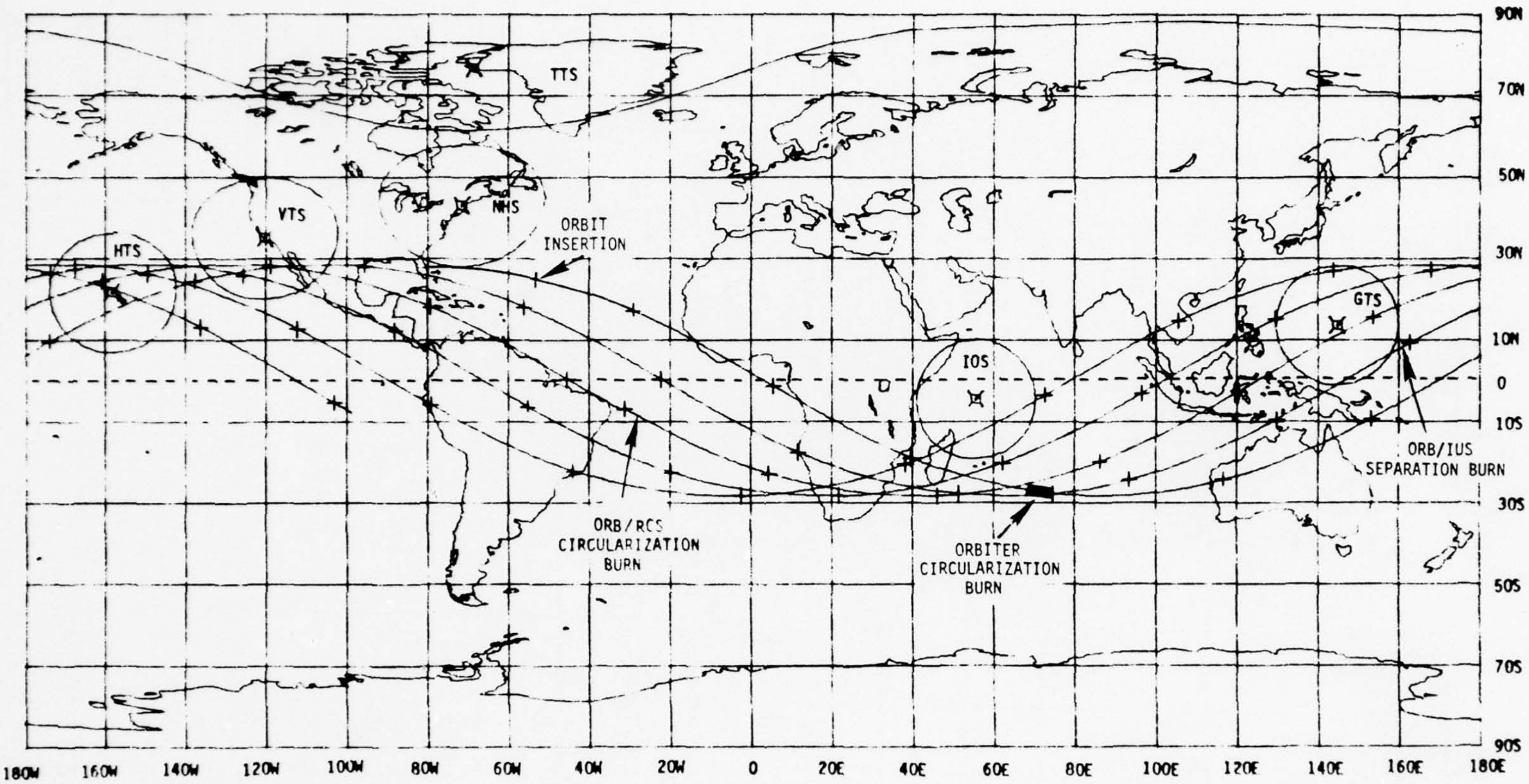


Figure 5-1. Orbiter Ground Track for Mission A, Orbit Insertion to Fifth Revolution

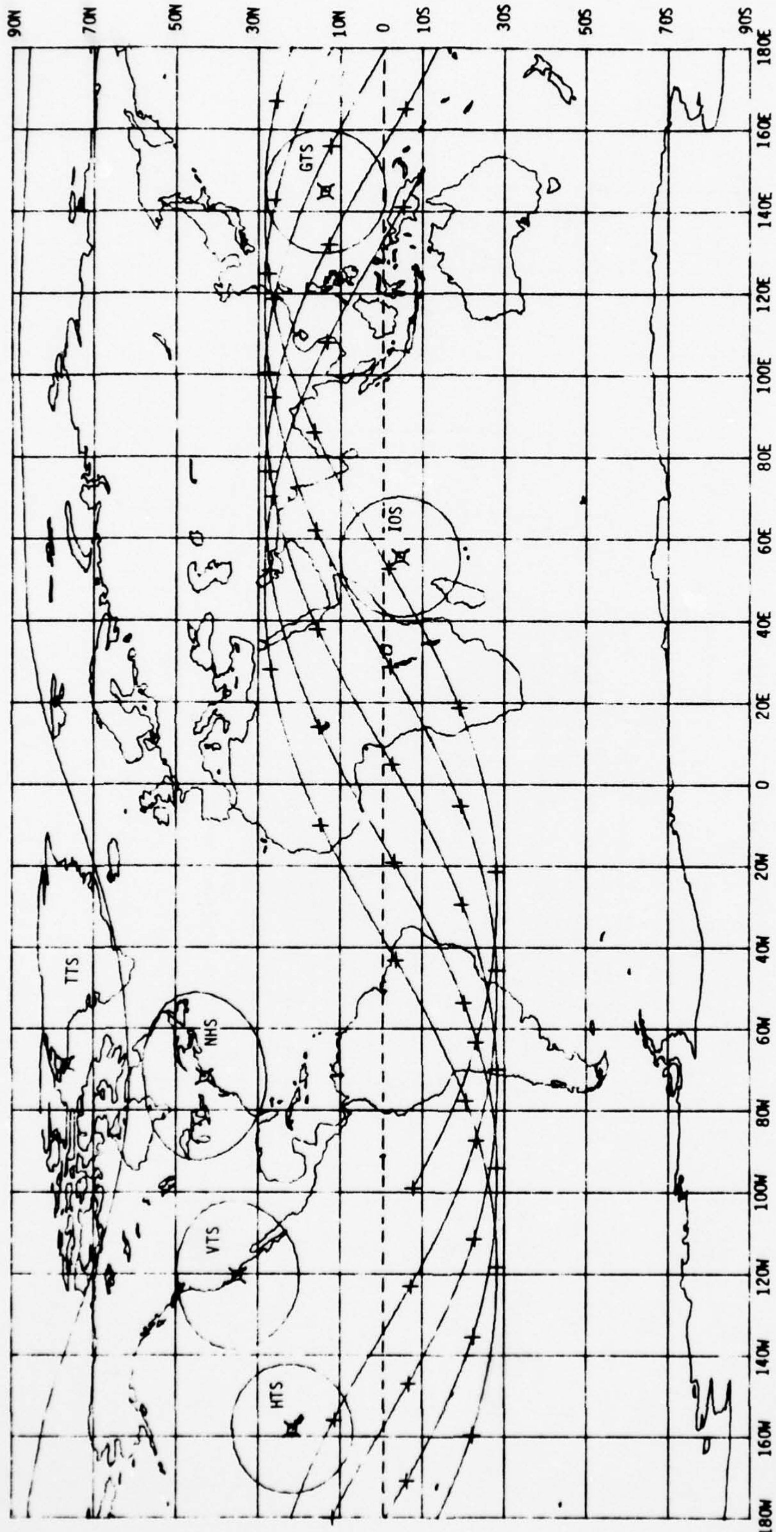


Figure 5-2. Orbiter Ground Track for Mission A, Sixth to Tenth Revolution

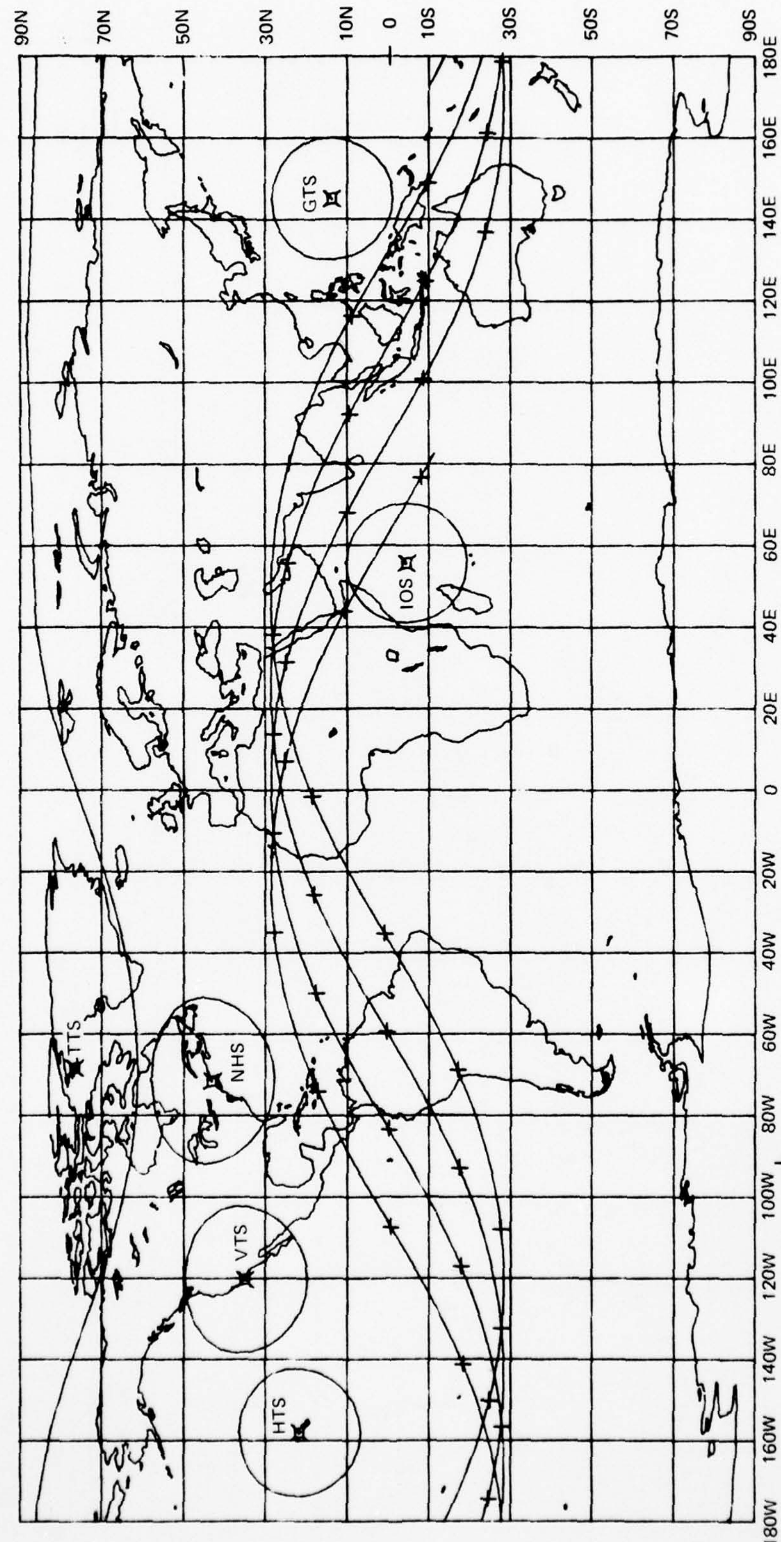


Figure 5-3 . Orbiter Ground Track for Mission A, Eleventh to Fifteenth Revolution

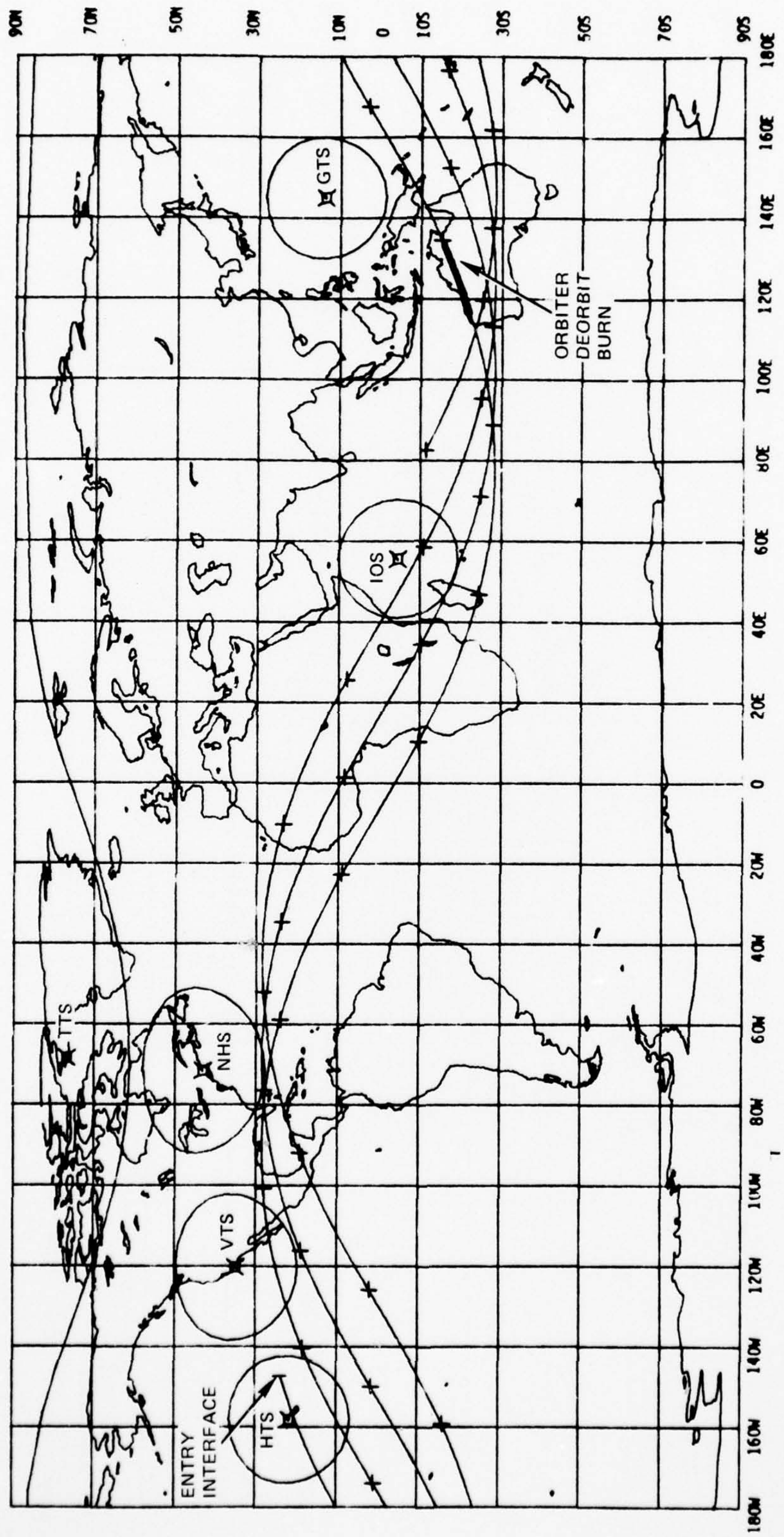


Figure 5-4. Orbiter Ground Track for Mission A, Sixteenth Revolution to Entry Interface

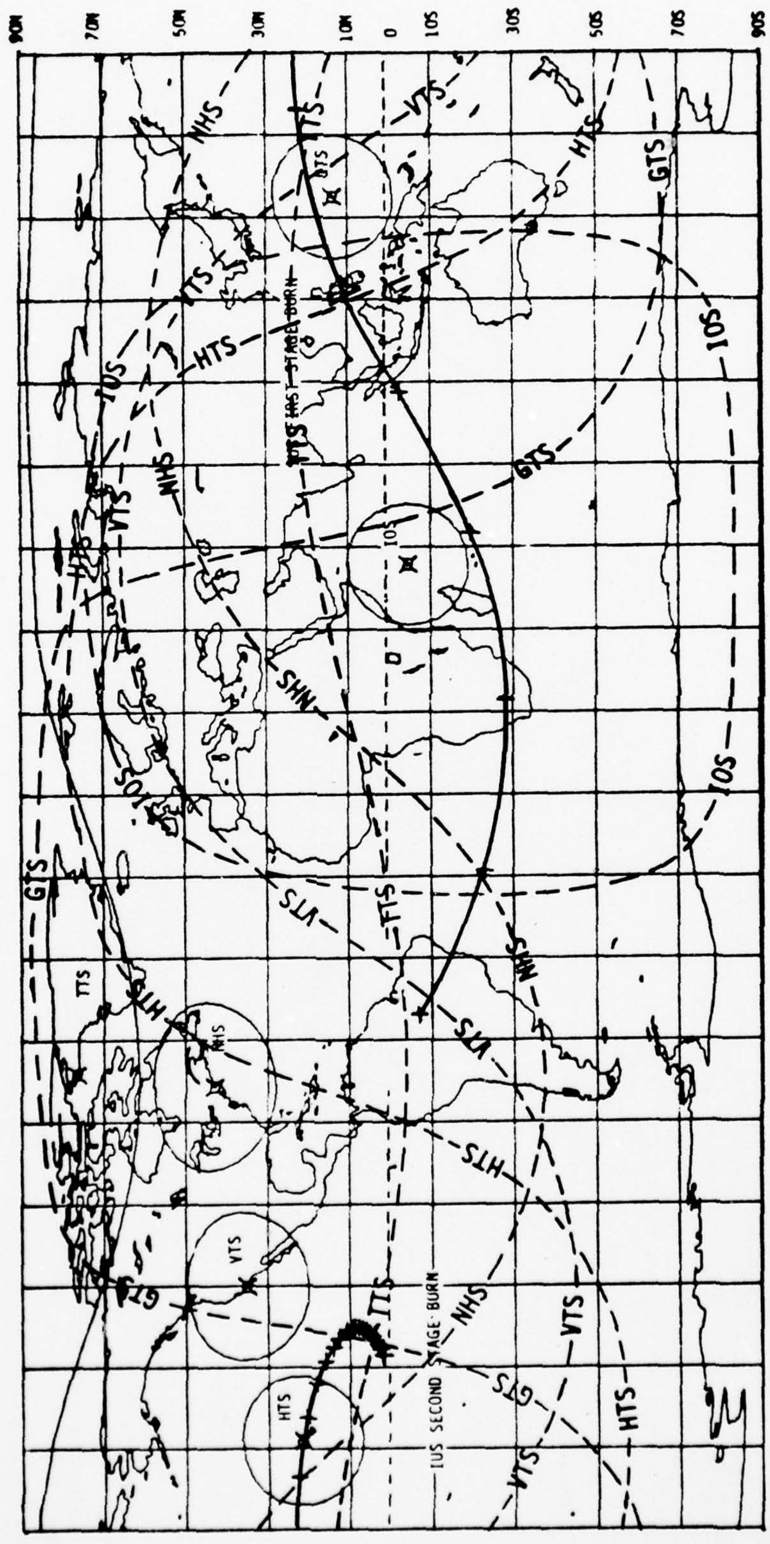


Figure 5-5 IUS Ground Track, Mission A, Fourth Ascending Node Transfer

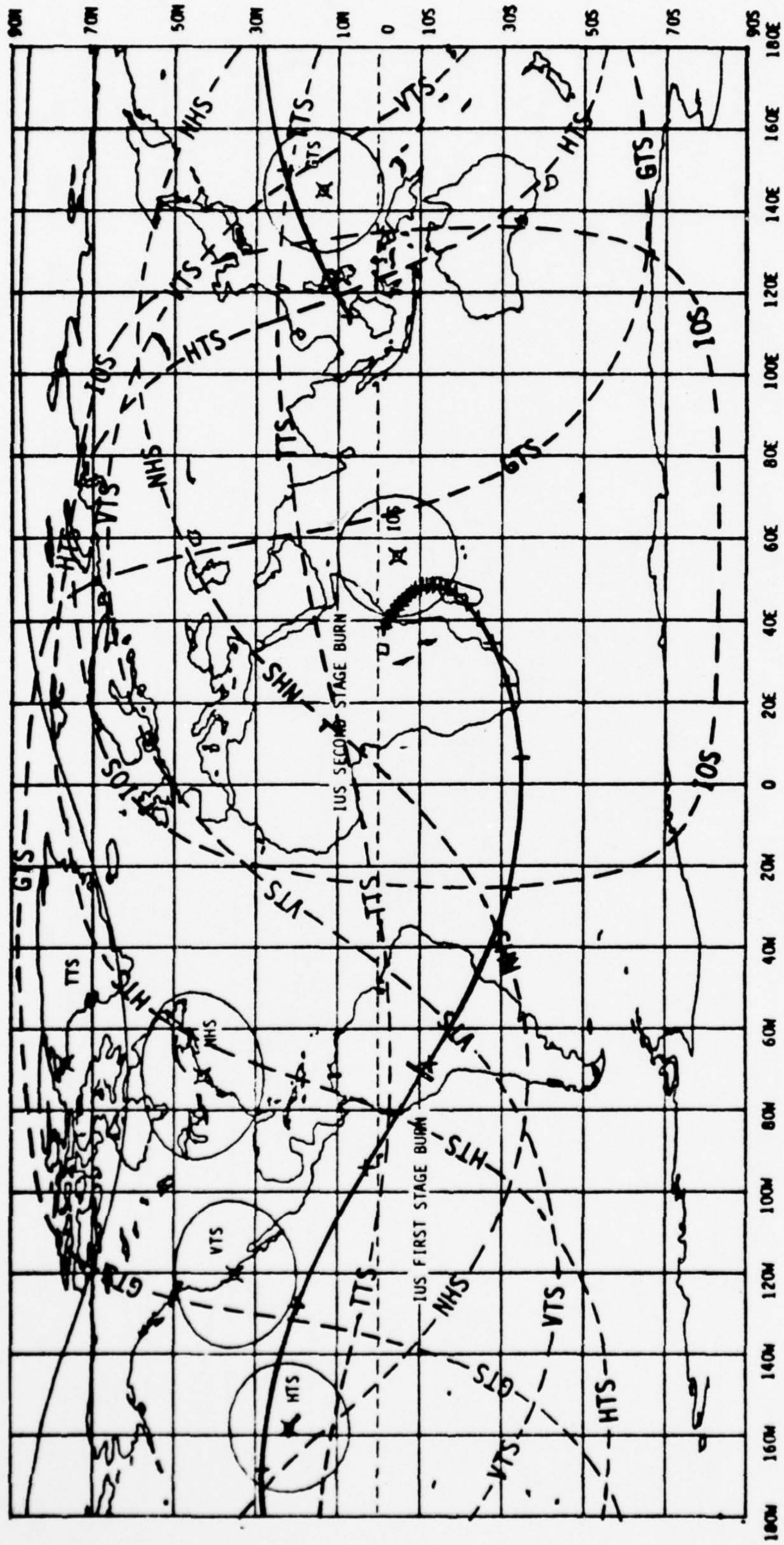


Figure 5-6 IUS Ground Track, Mission A, Fifth Descending Node Transfer

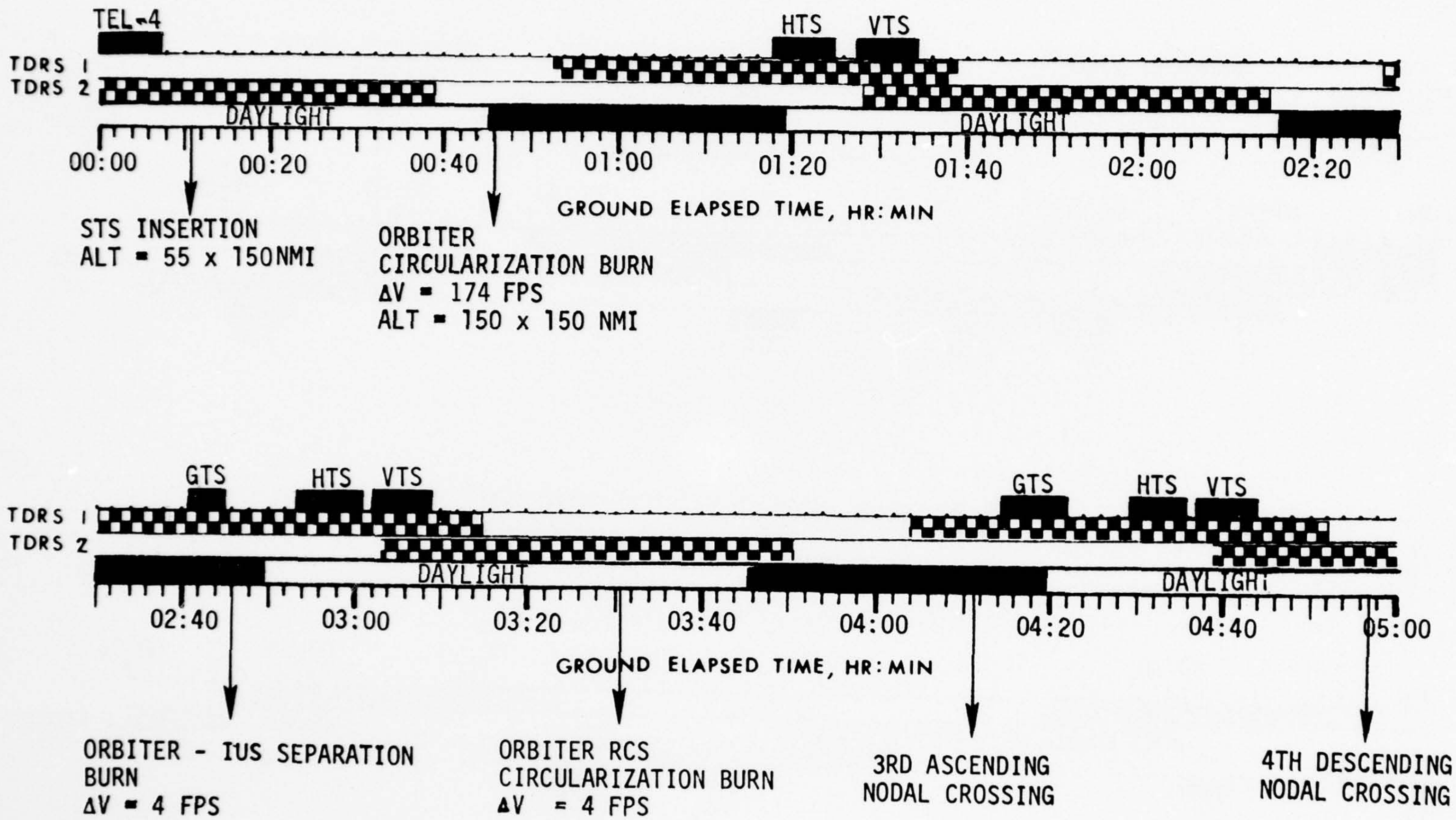


Figure 5-7. Orbiter Tracking, Lighting, and Maneuver Events Summary for Mission A

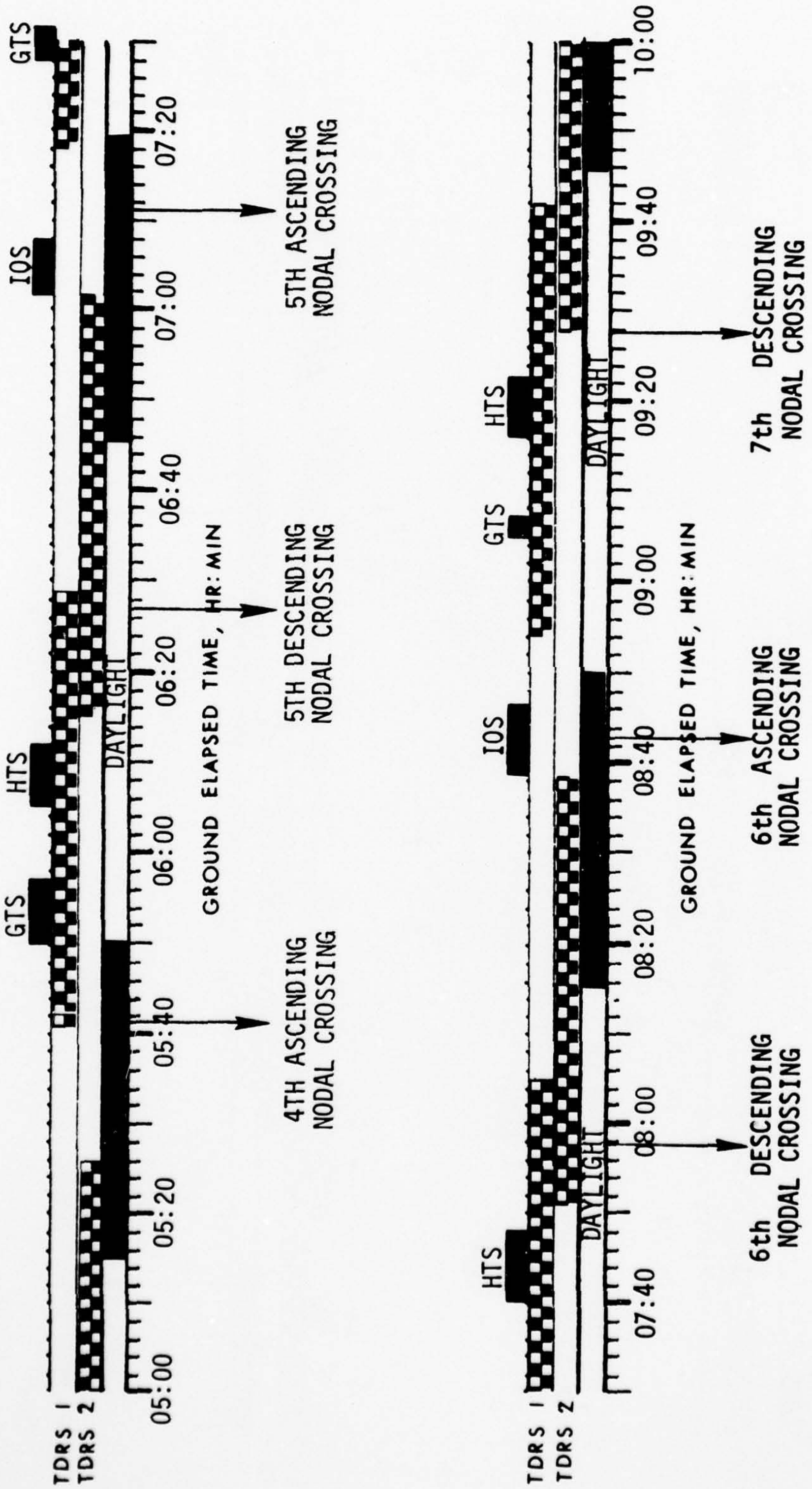


Figure 5-7. Orbiter Tracking, Lighting, and Maneuver Events Summary for Mission A (Continued)

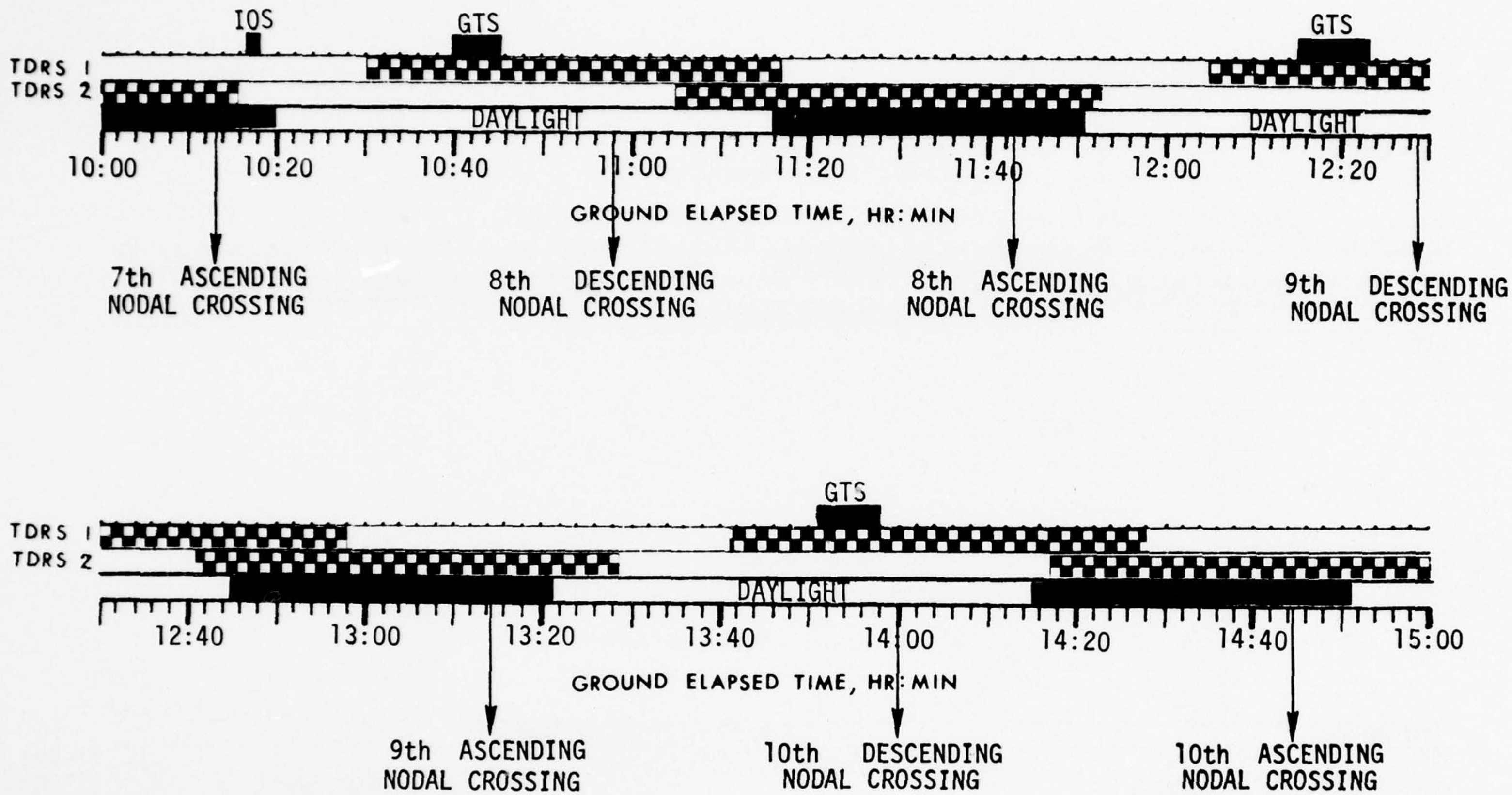


Figure 5-7. Orbiter Tracking, Lighting, and Maneuver Events Summary for Mission A (Continued)

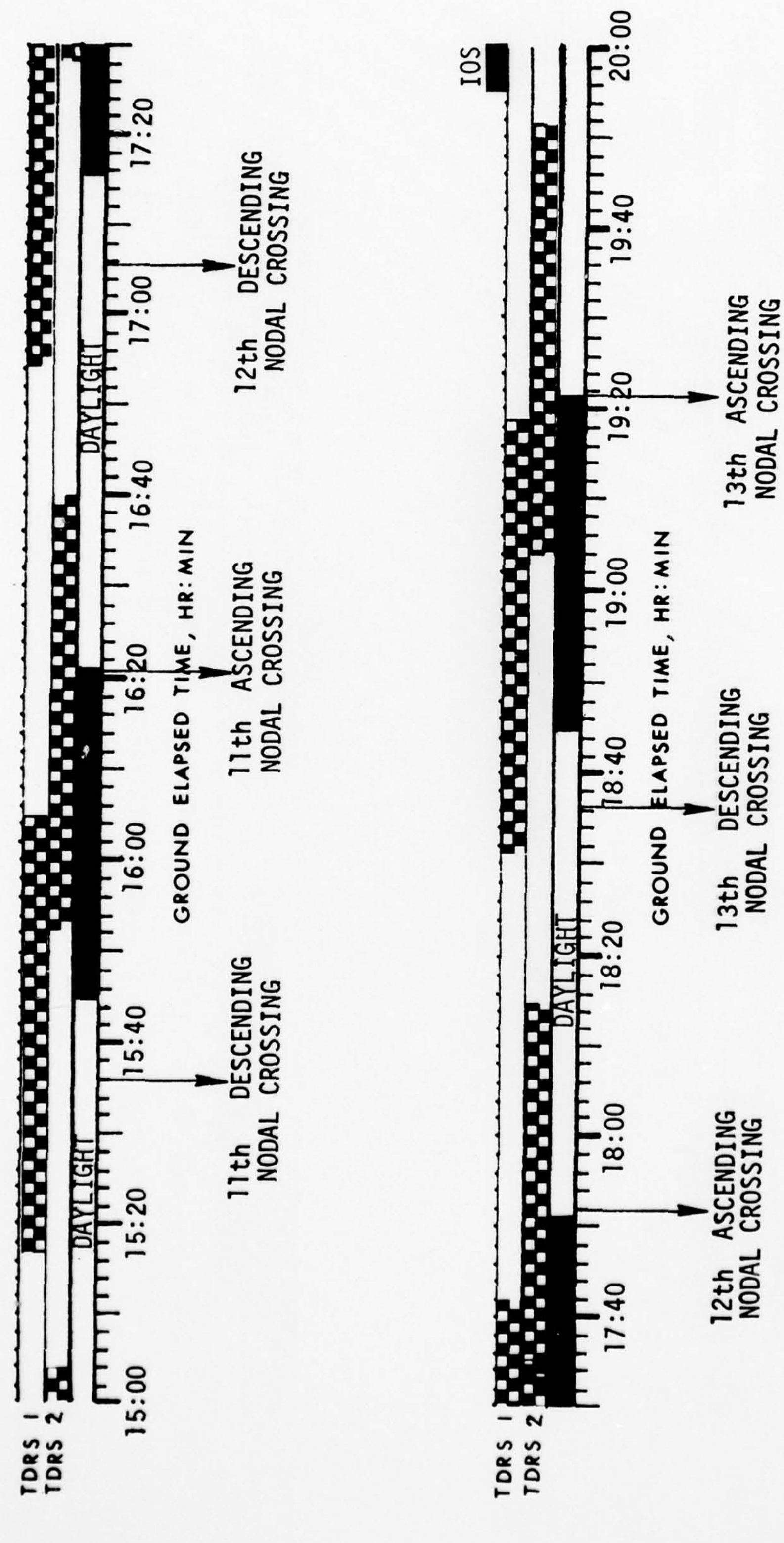


Figure 5-7. Orbiter Tracking, Lighting, and Maneuver Events Summary for Mission A (Continued)

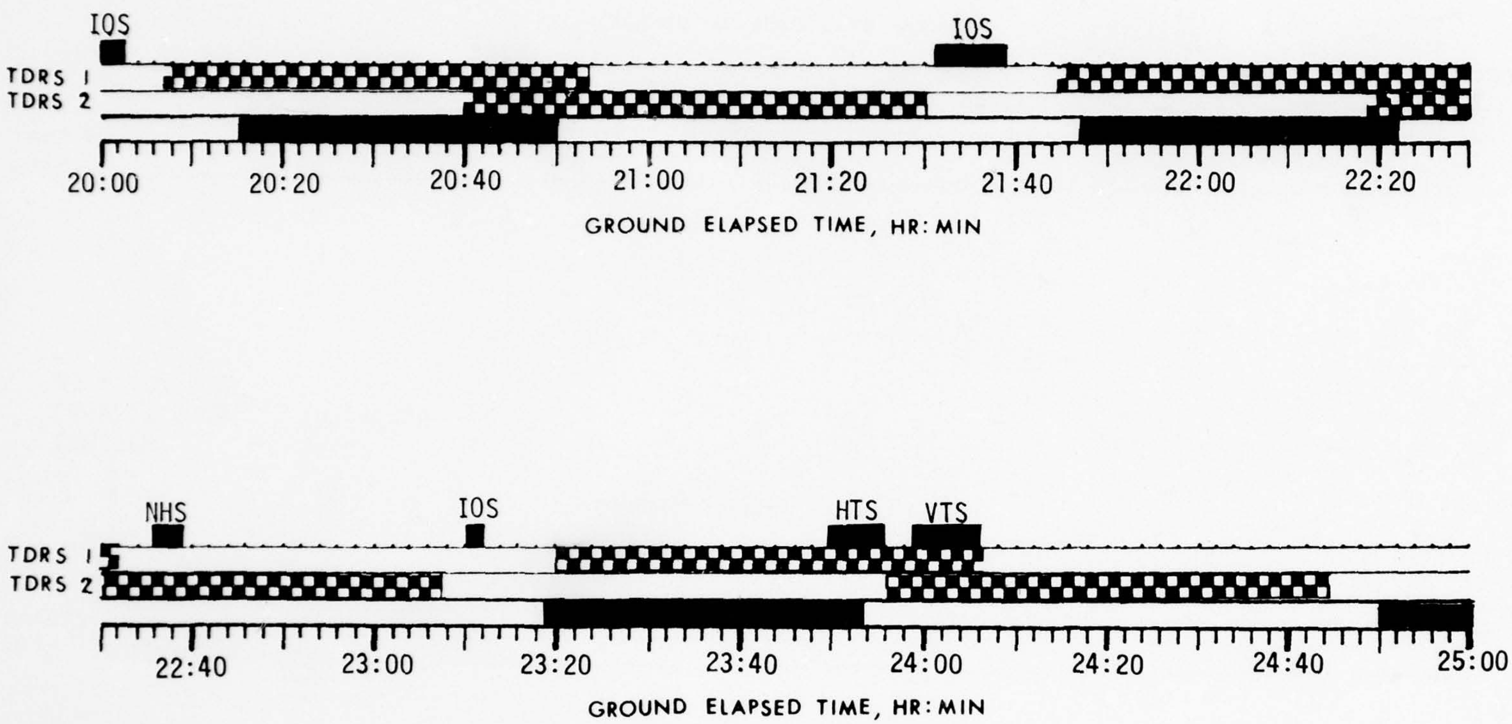


Figure 5-7. Orbiter Tracking, Lighting, and Maneuver Events Summary for Mission A (Continued)

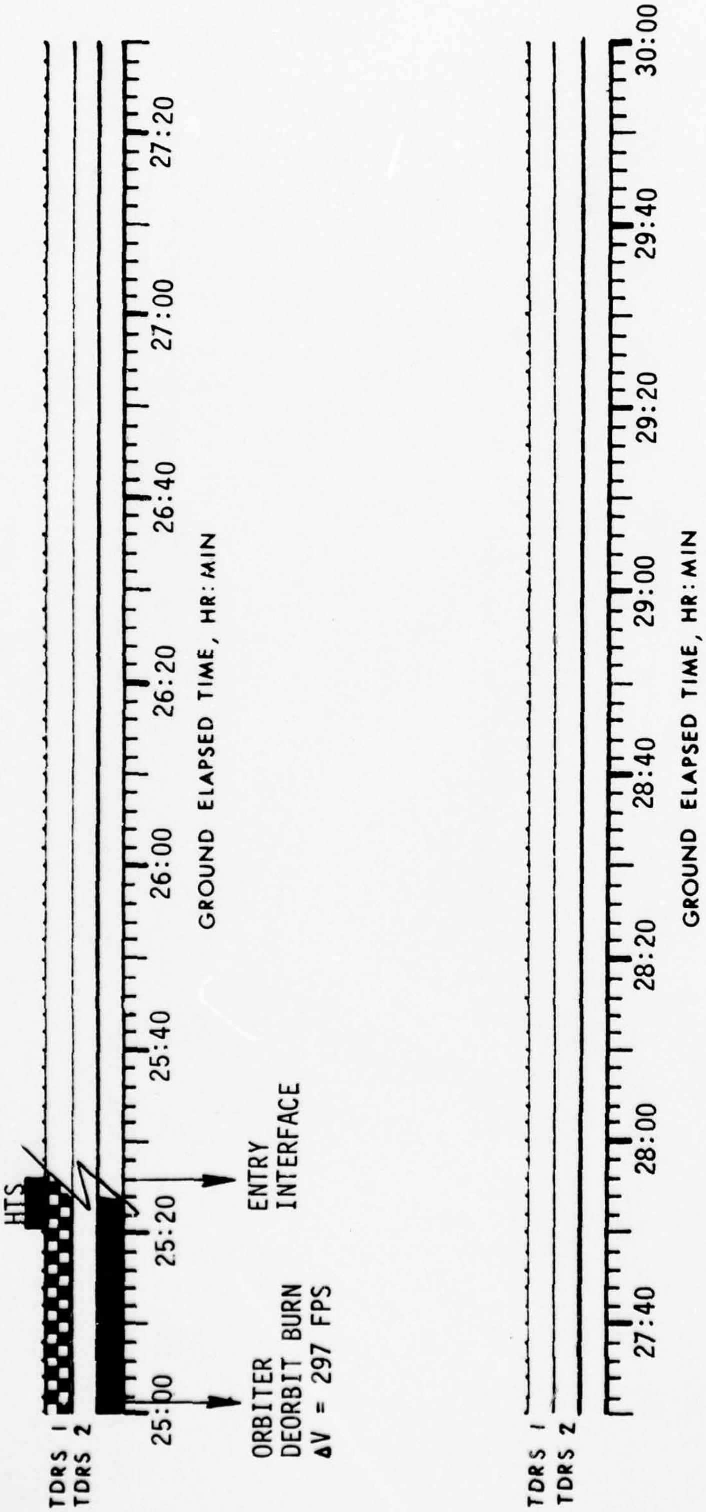


Figure 5-7. Orbiter Tracking, Lighting, and Maneuver Events Summary for Mission A (Concluded)

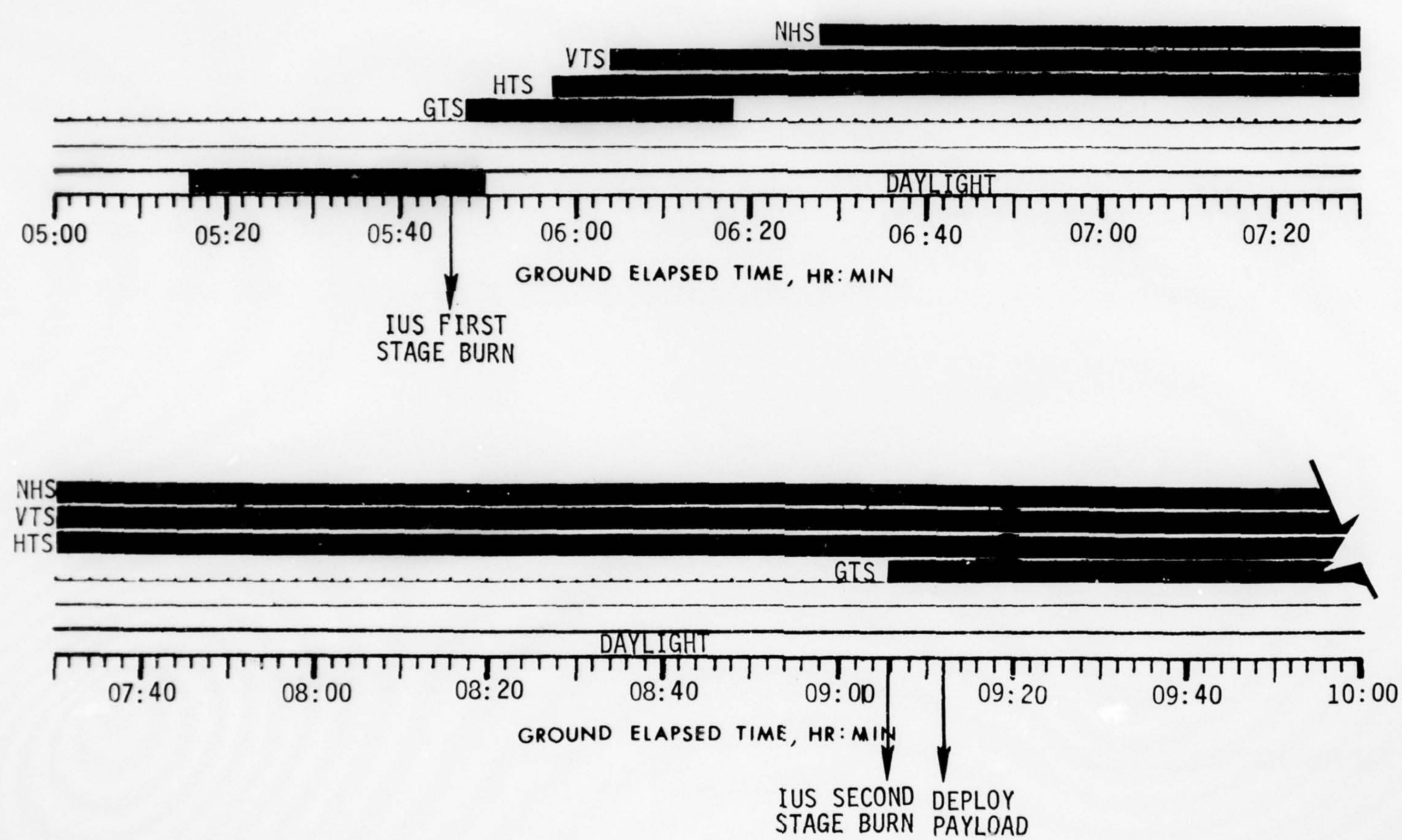


Figure 5-8. IUS Tracking, Lighting, and Maneuver Events Summary for Mission A (Fourth Ascending Node Transfer)

AD-A045 100 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 22/3

DEPARTMENT OF DEFENSE SPACE TRANSPORTATION SYSTEM (DOD/STS) MIS--ETC(U)

SEP 77 G S GEDEON, J R OWEN, R D TOMLINSON F04701-75-C-0025

UNCLASSIFIED TRW-26937-6136-TU-00 SAMSO-TR-77-116 NL

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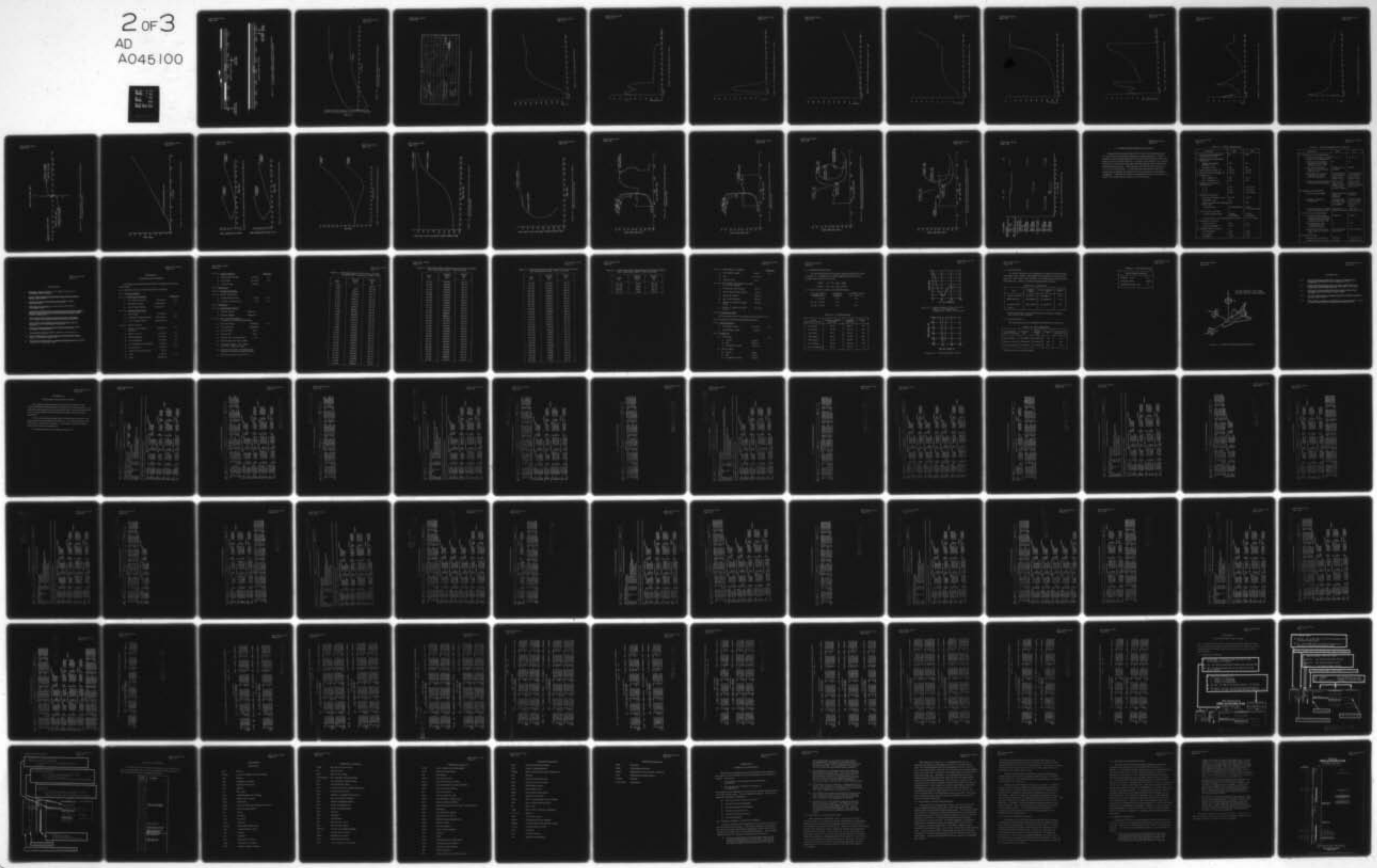

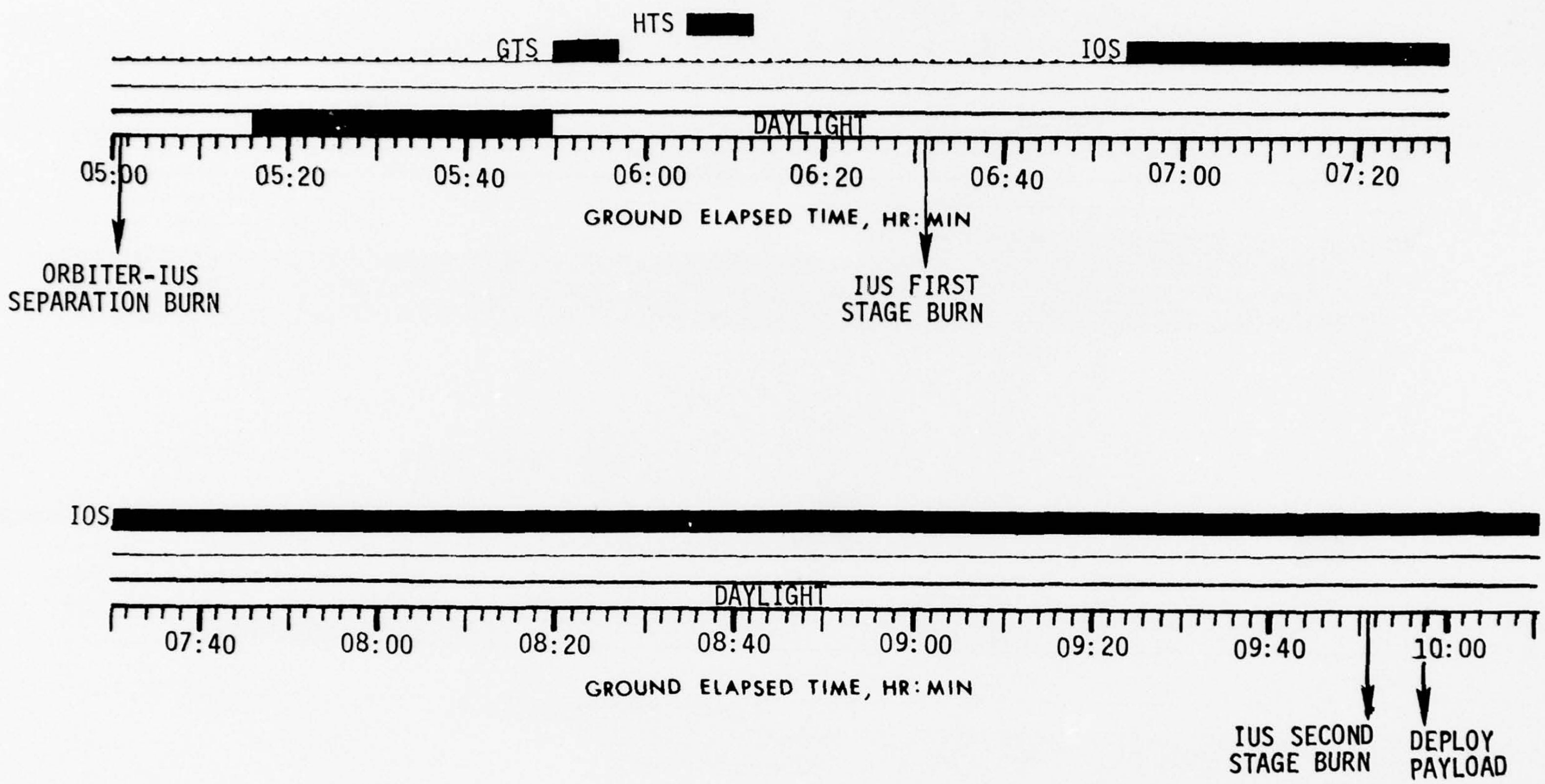

Figure 5- 9. IUS Tracking, Lighting, and Maneuver Events Summary for Mission A (Fifth Descending Node Transfer)

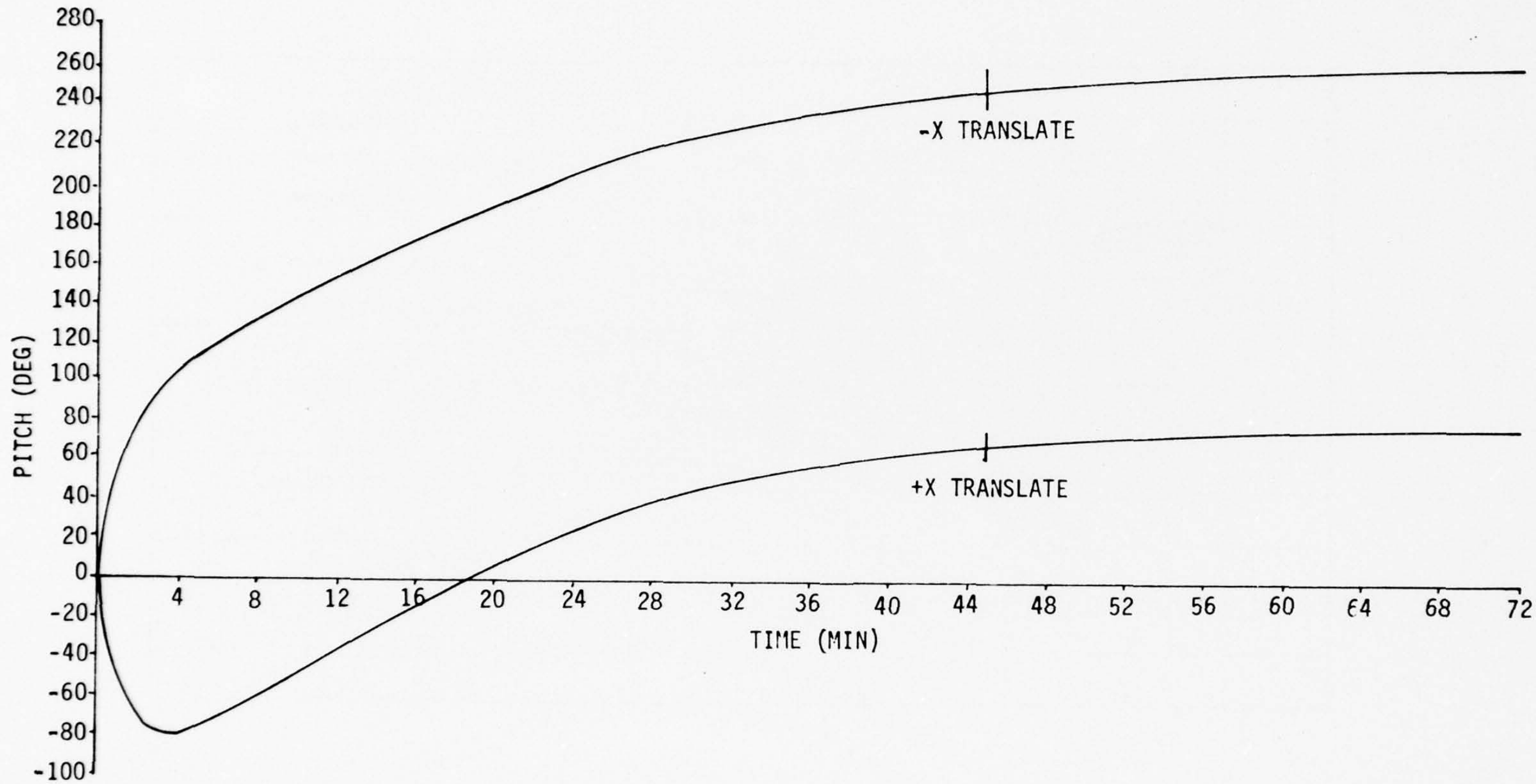

Figure 5-10. Pitch Attitudes Following IUS/Orbiter Separation
(Points-Z Axis at IUS)

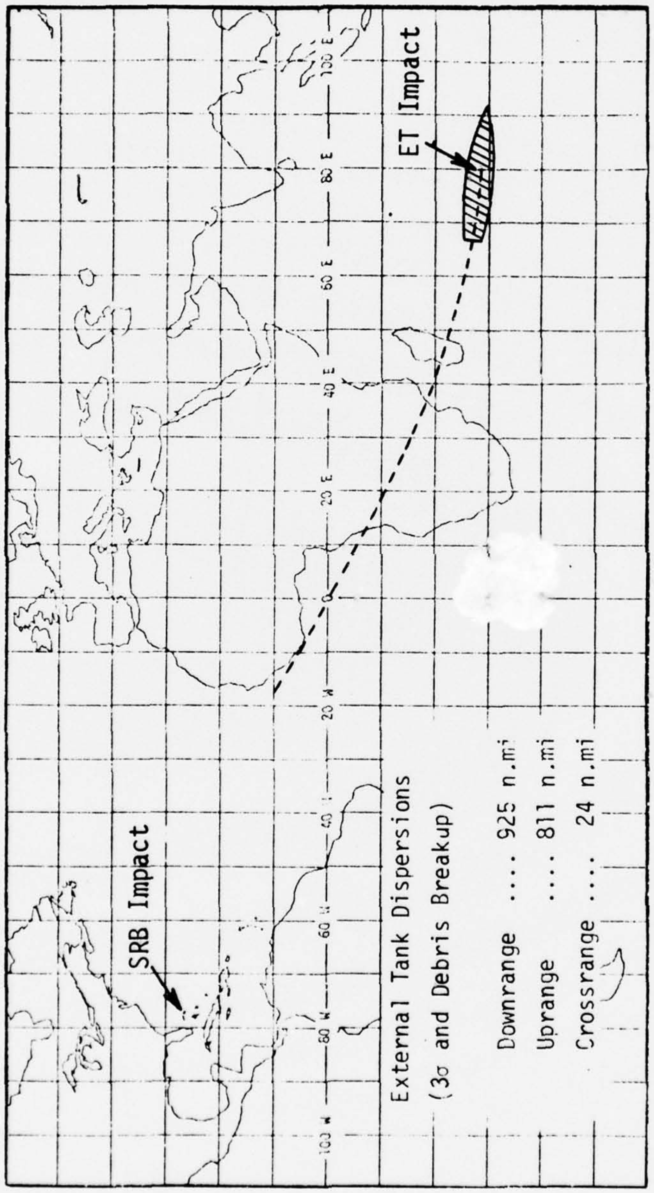

Figure 5-11. SRB and External Tank Impact Points

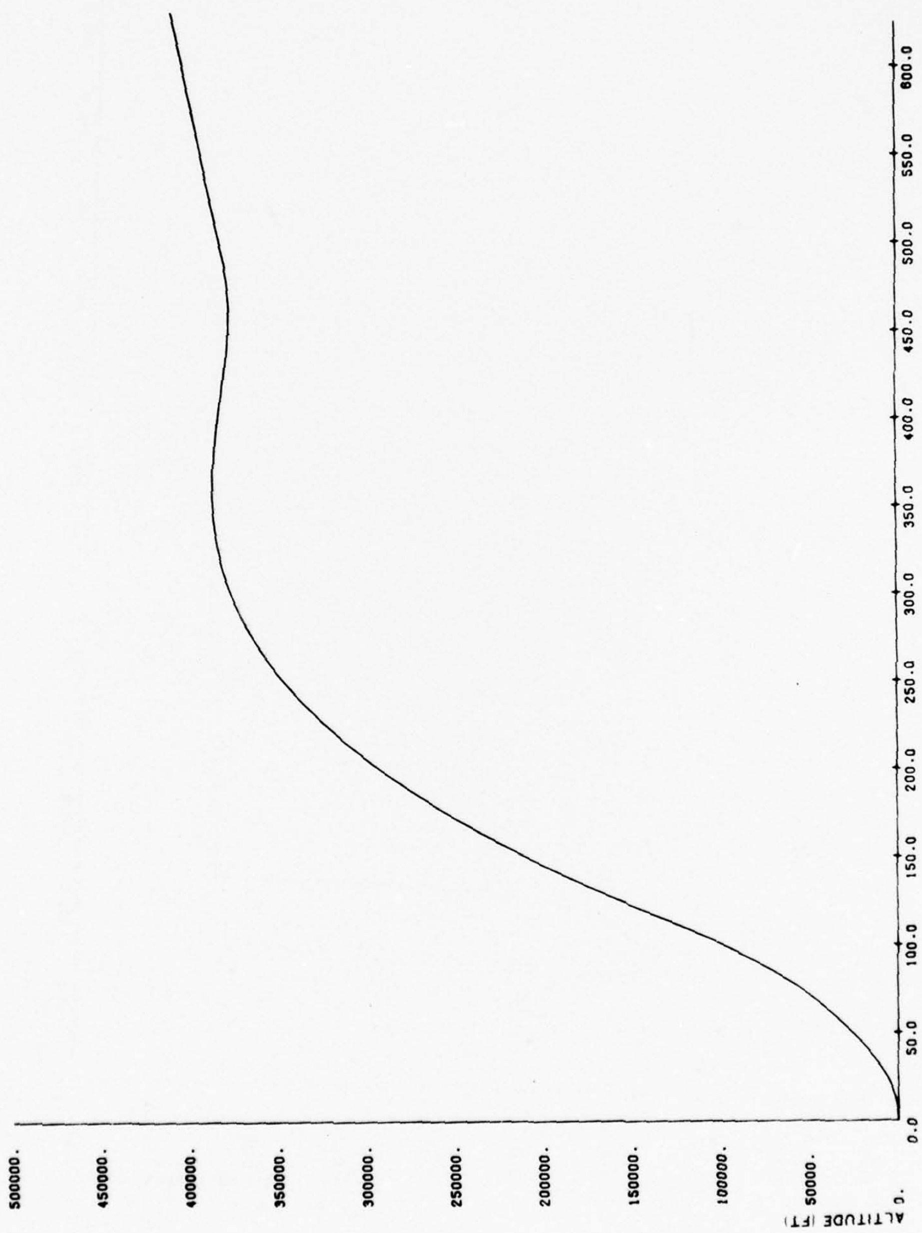

Figure 5-12. Ascent Phase Altitude Profile

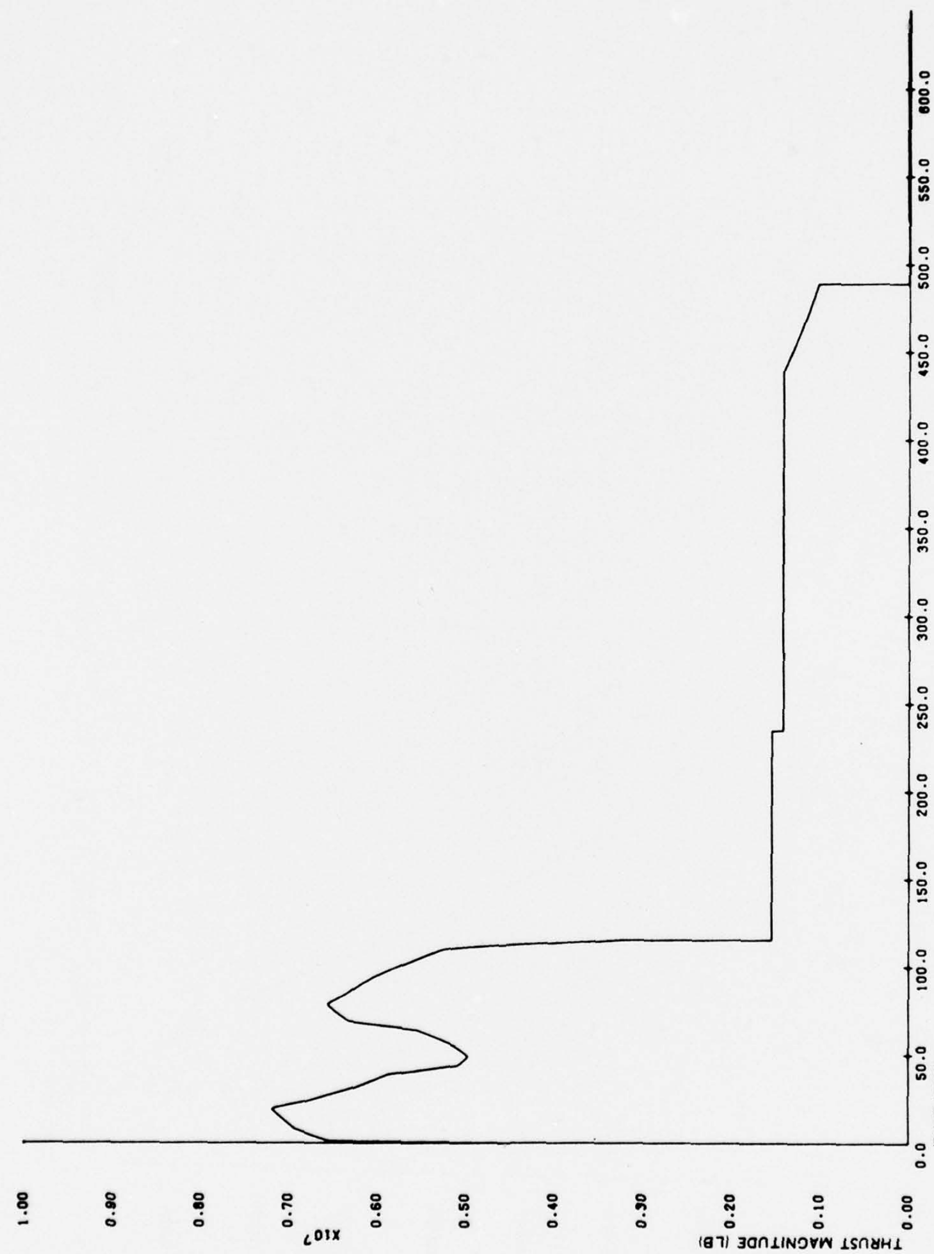

Figure 5-13. Ascent Phase Thrust vs. Time

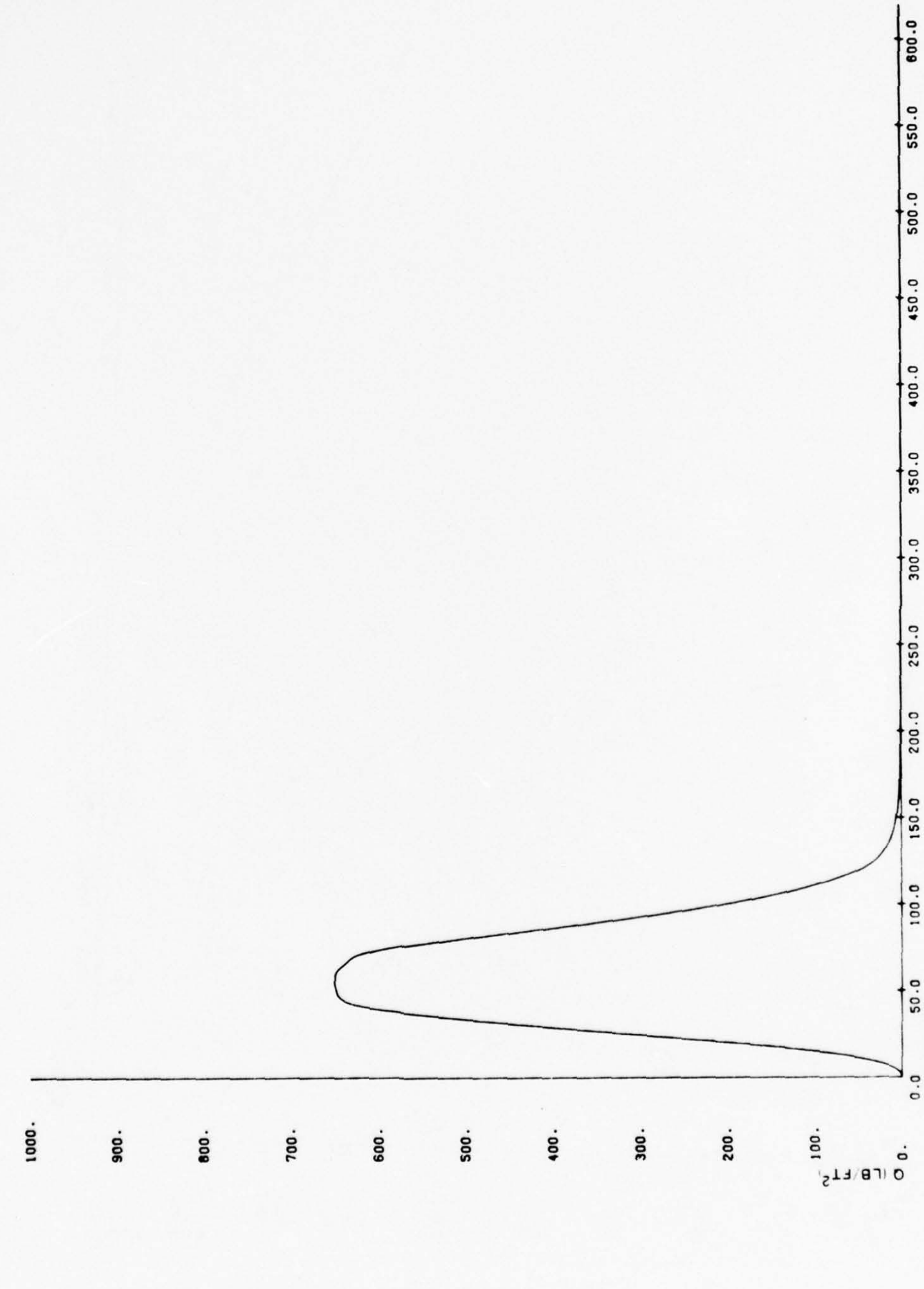

Figure 5-14. Ascent Phase Dynamic Pressure, Q, vs. Time

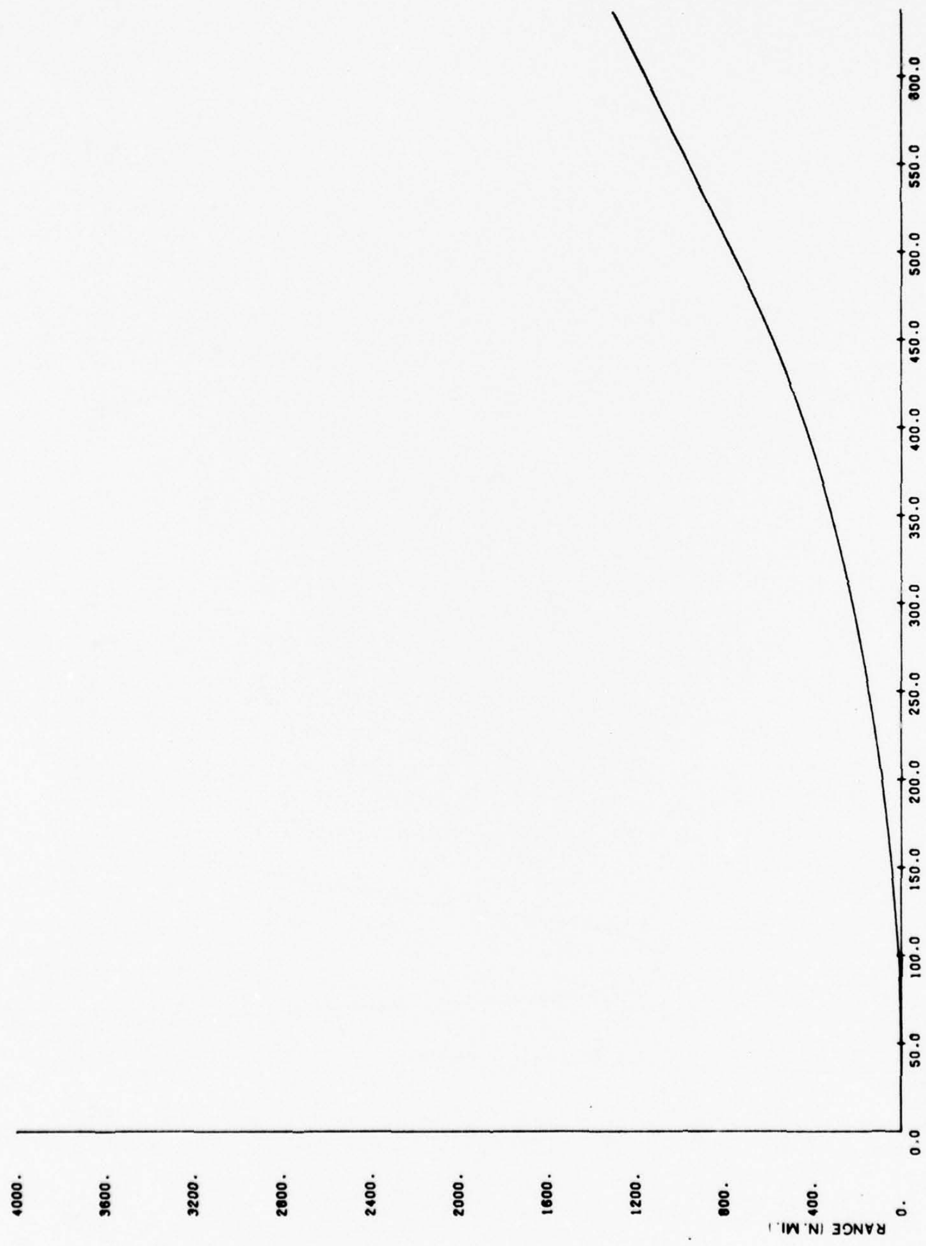

Figure 5-15. Ascent Phase Range from Launch vs. Time

Figure 5-16. Ascent Phase Height of Apogee vs. Time

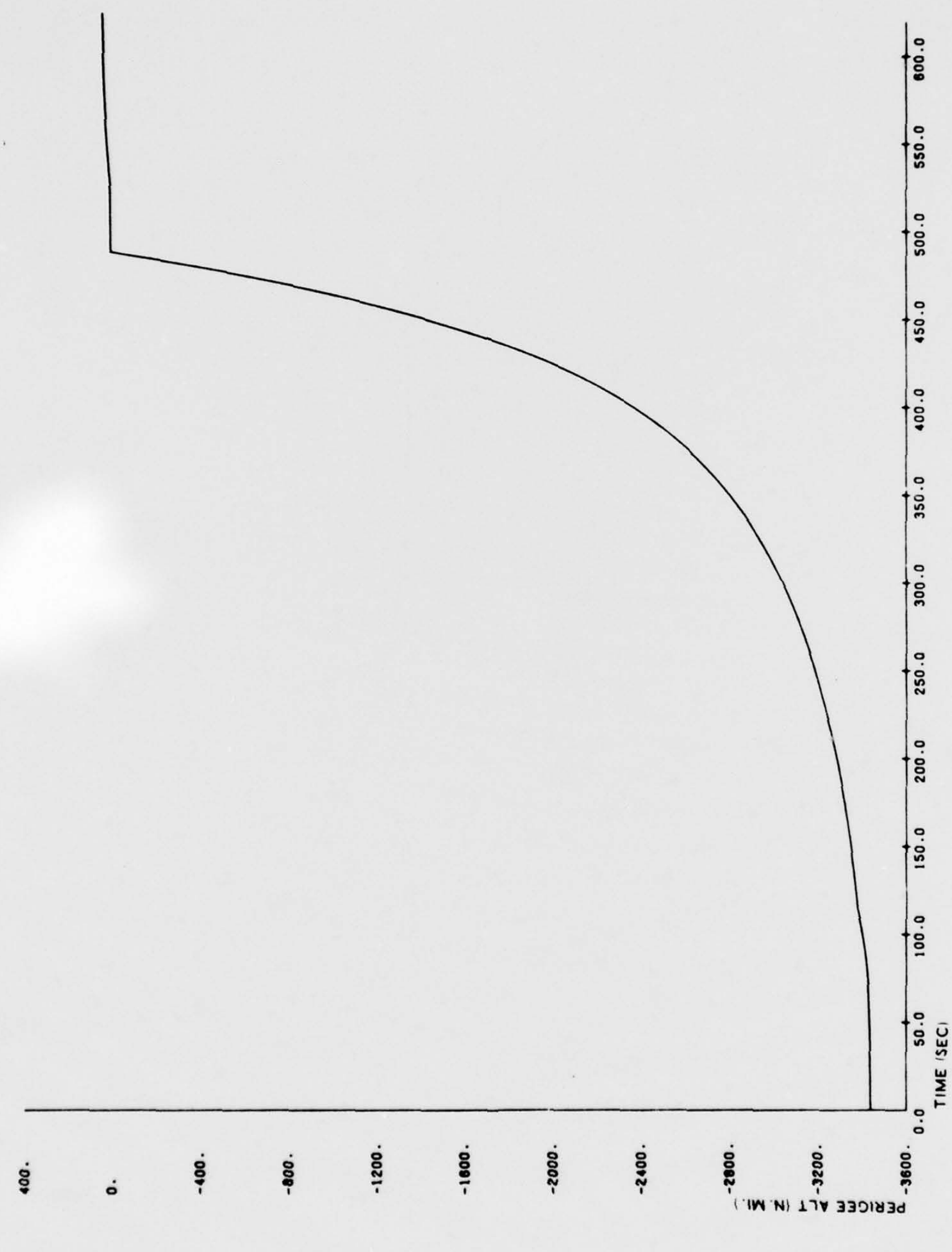

Figure 5-17. Ascent Phase Height of Perigee vs. Time

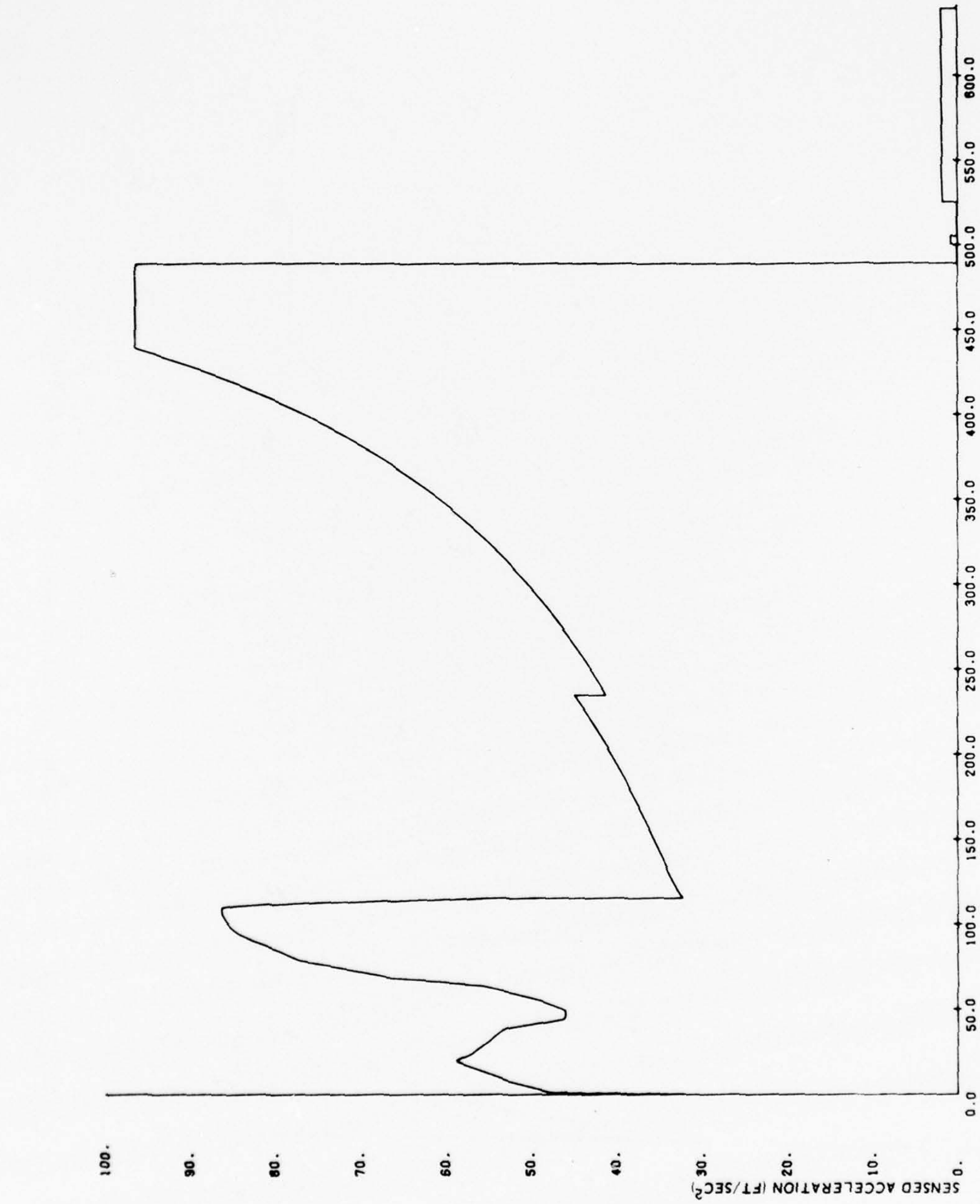

Figure 5-18. Ascent Phase Inertial Acceleration Profile

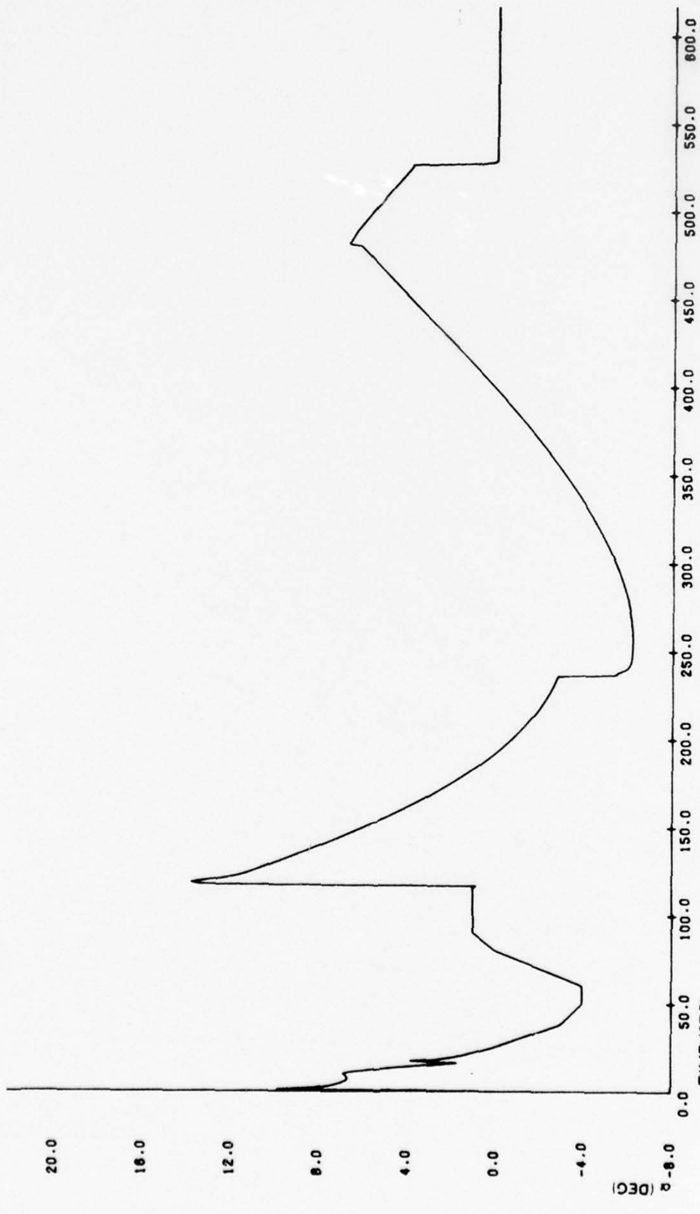

Figure 5-19. Ascent Phase Pitch Angle of Attack (α) vs. Time

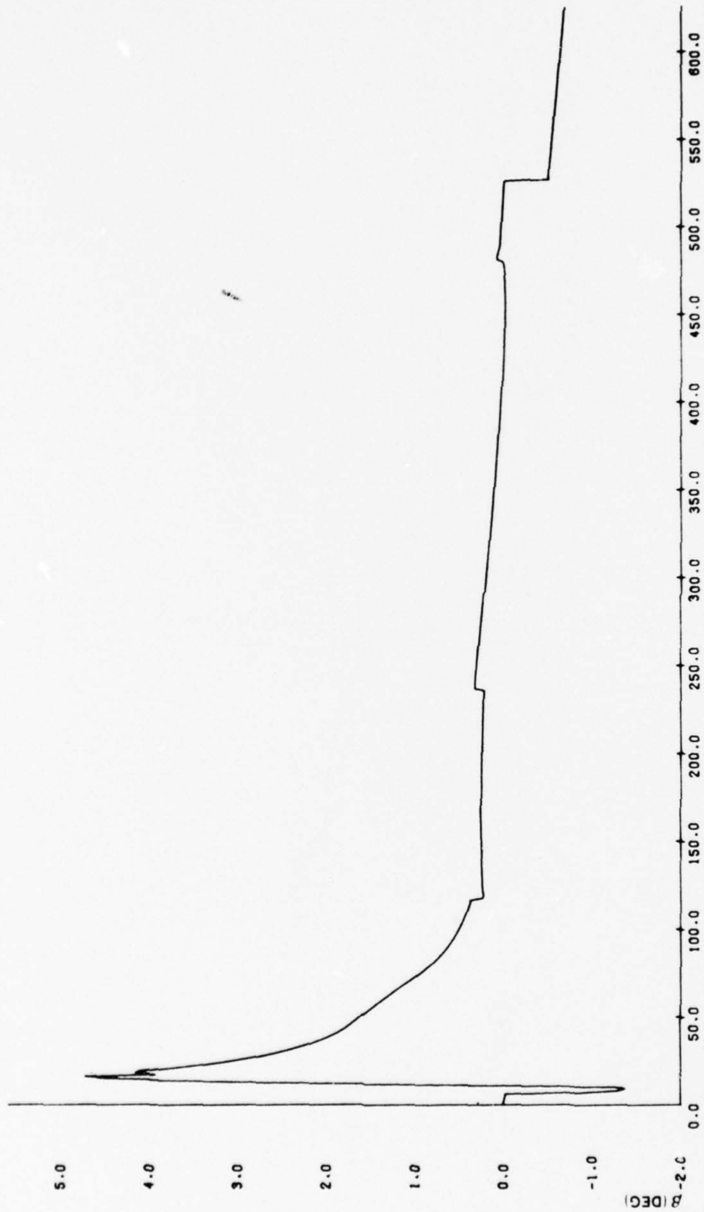

Figure 5-20. Ascent Phase Sideslip Angle (β) vs. Time

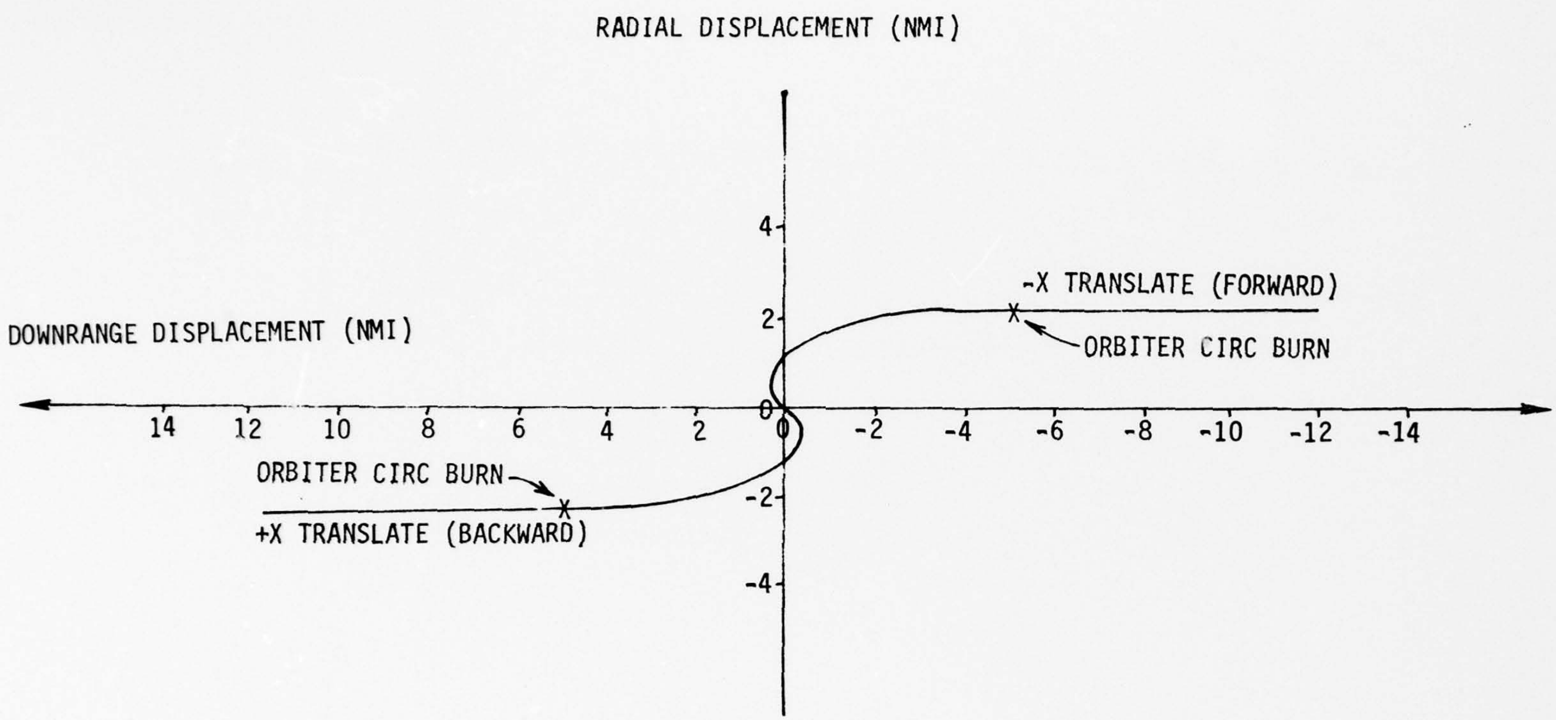

Figure 5-21. Orbiter Downrange vs. Radial Displacement from IUS Following P/L Separation Burn (4 fps)

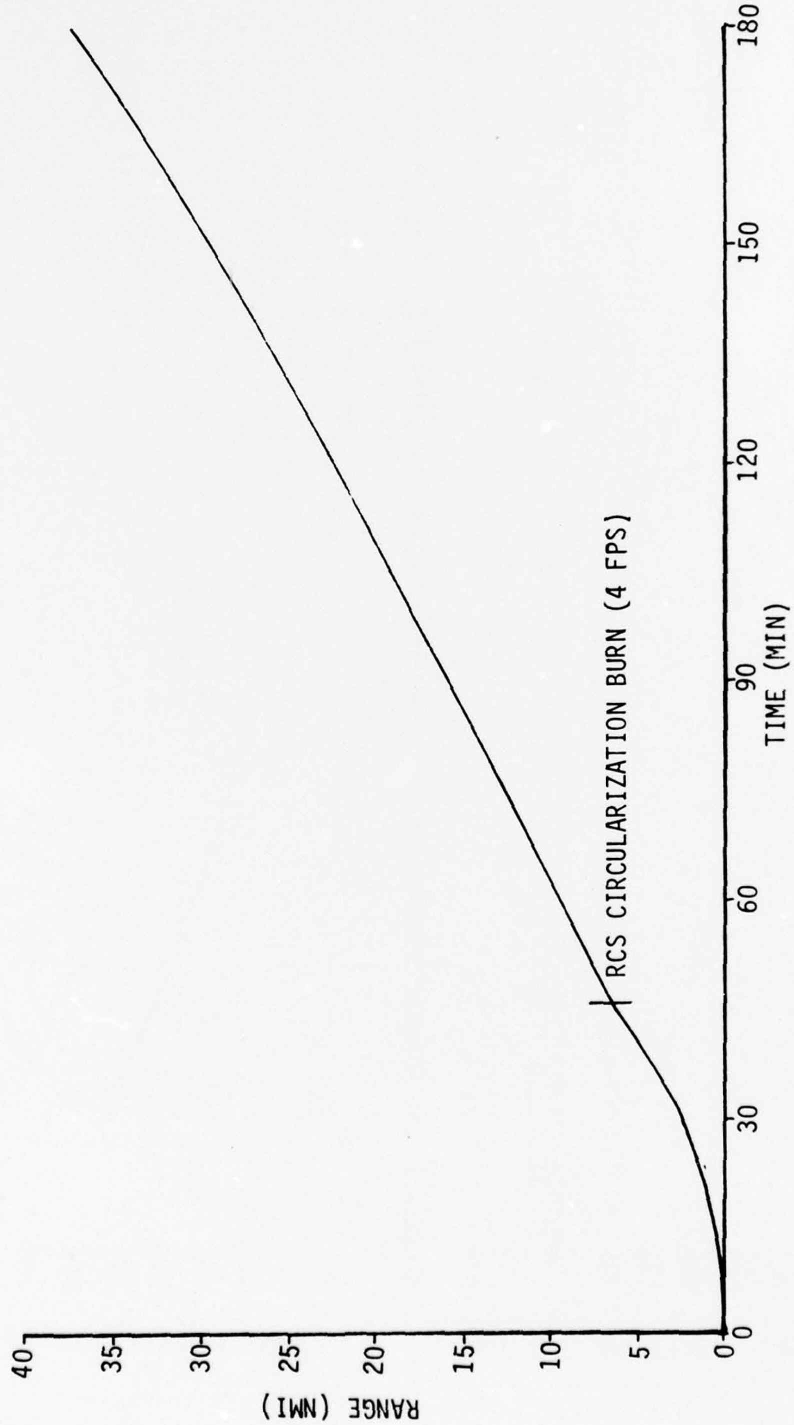

Figure 5-22. Orbiter Range from IUS Following P/L Separation Burn (4fps)

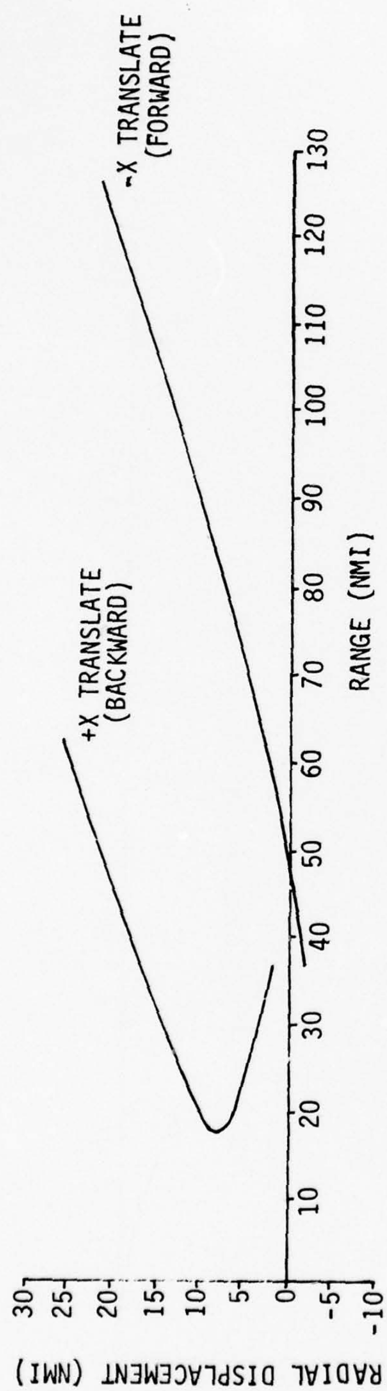

Figure 5-23. Radial Displacement Relative Motion During IUS First Stage Burn

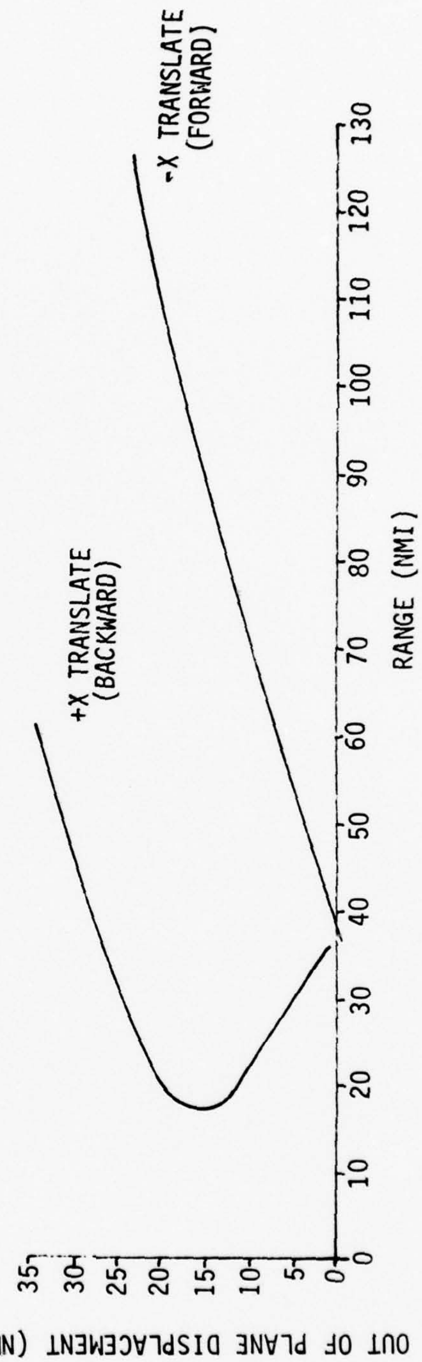

Figure 5-24. Out-of-Plane Relative Motion During IUS First Stage Burn

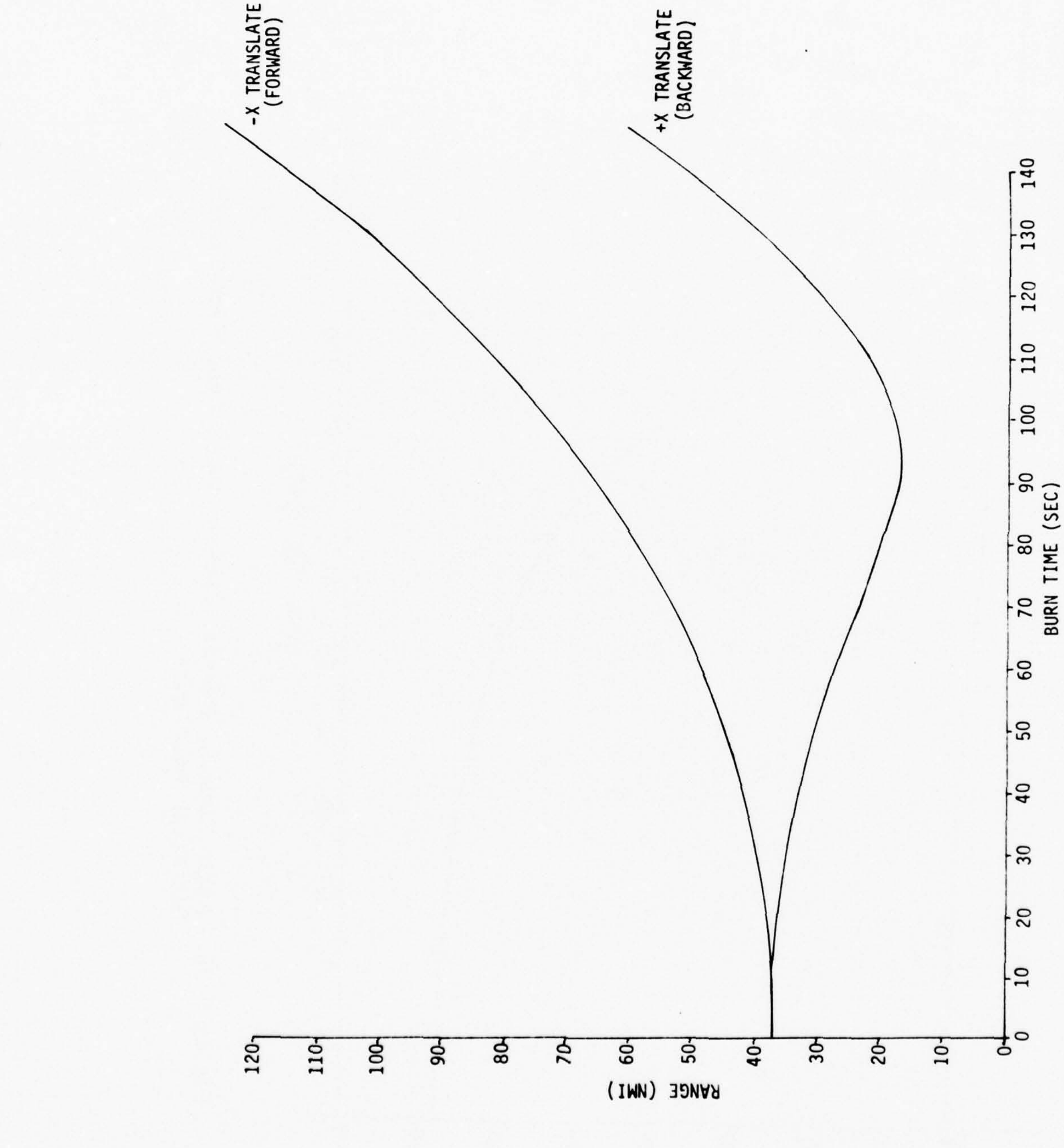

Figure 5-25. Orbiter/IUS Separation During IUS First Stage Burn

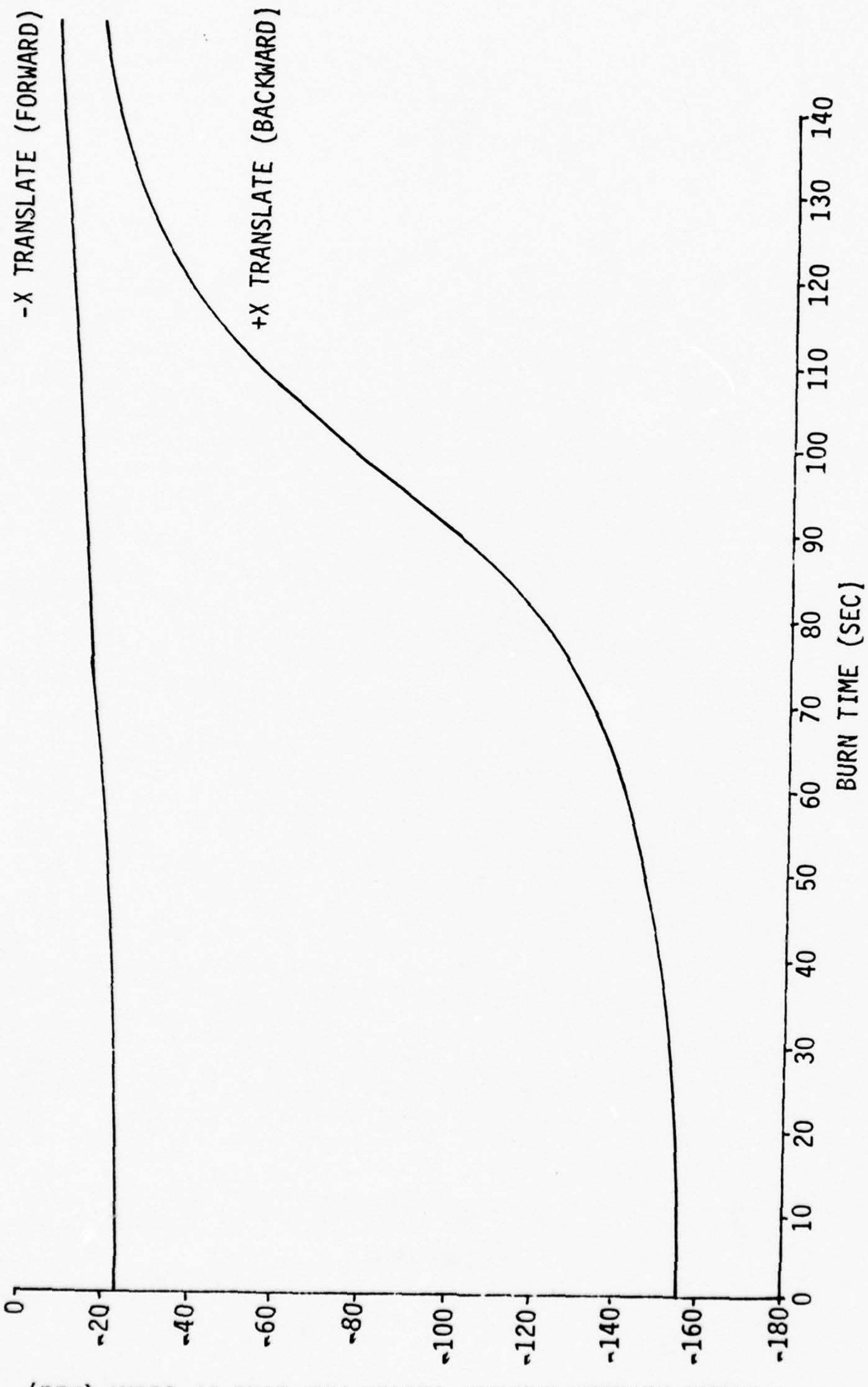

Figure 5-26. Angle Between Exhaust Vector and LOS vs. Burn Time for IUS First Stage Burn

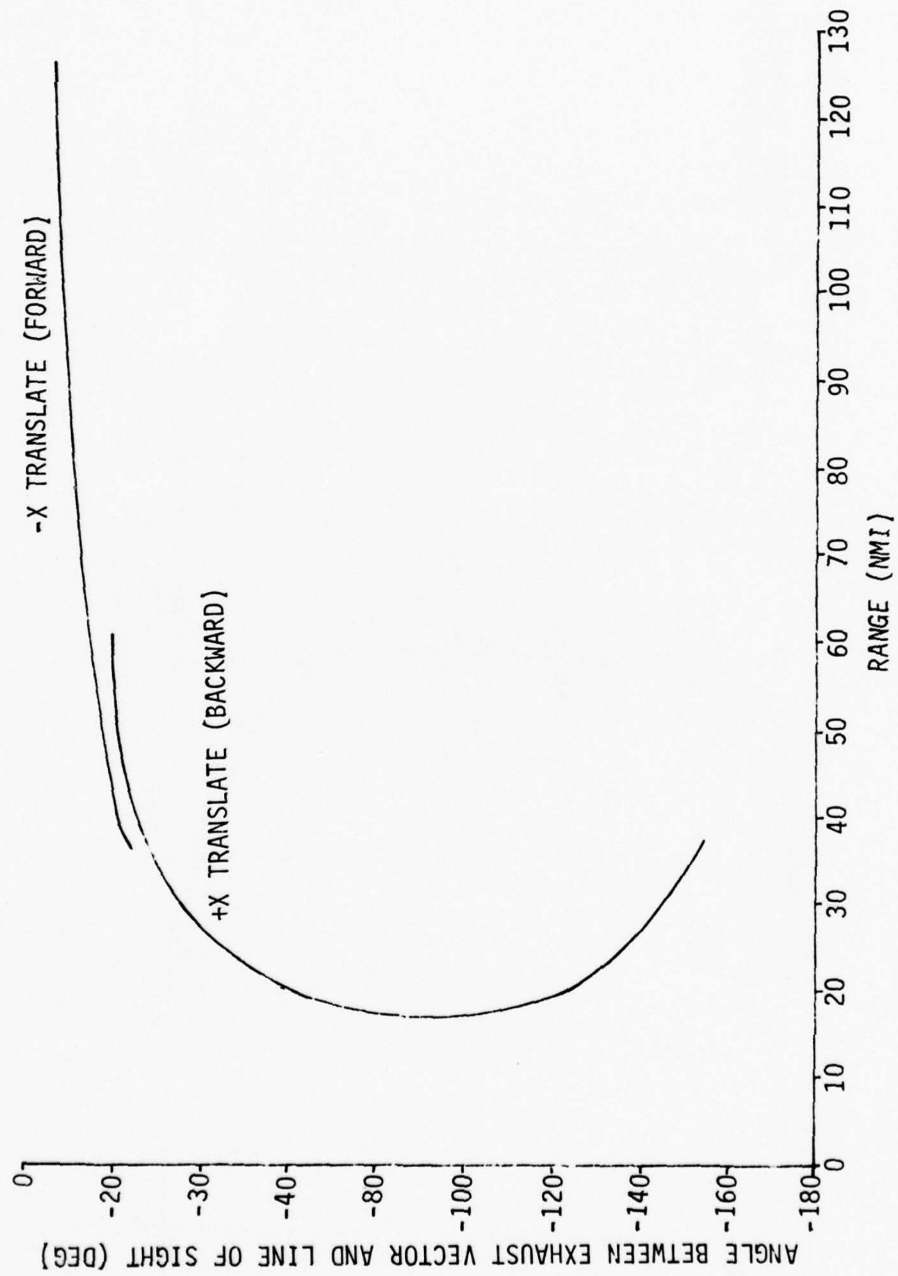

Figure 5-27. Angle Between Exhaust Vector and Line of Sight vs. Range for IUS First Stage Burn

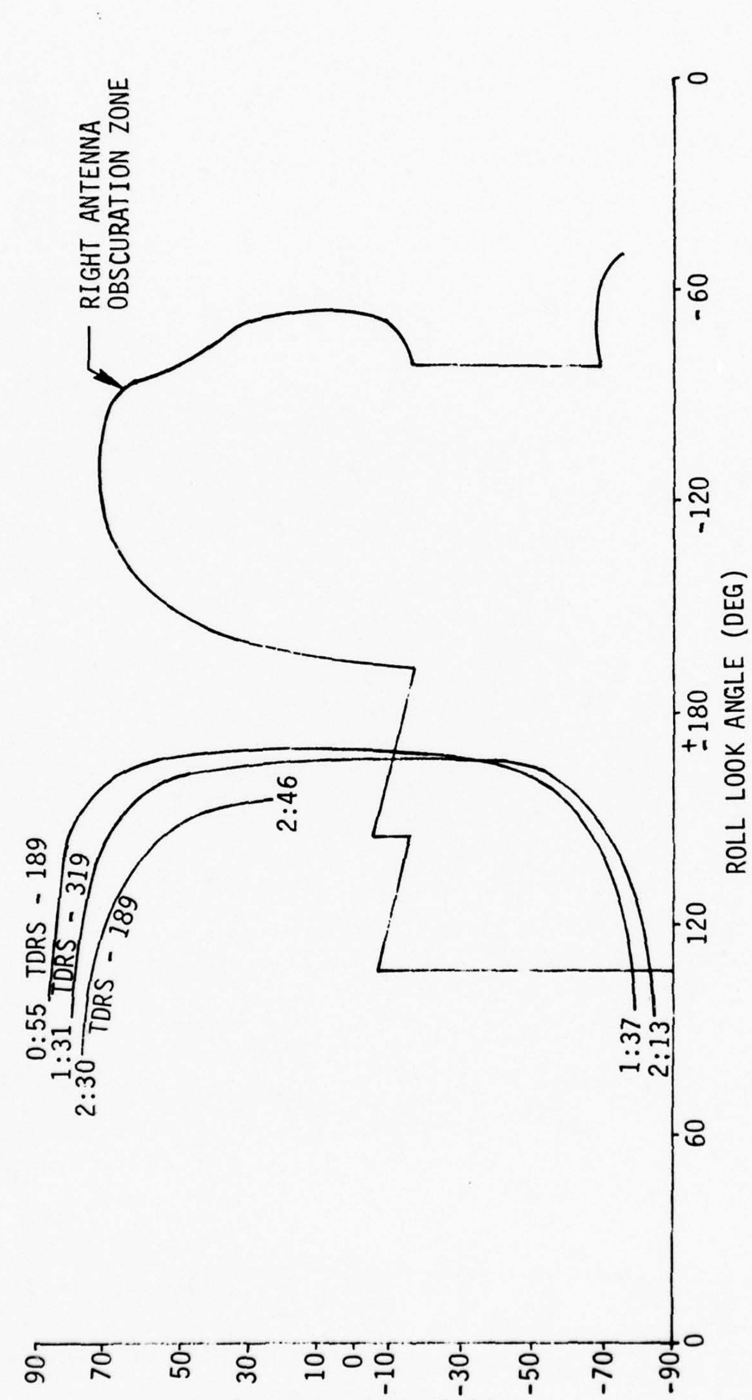

Figure 5-28. TDRS Look Angles Overlayed with Right Antenna Obscuration Zone

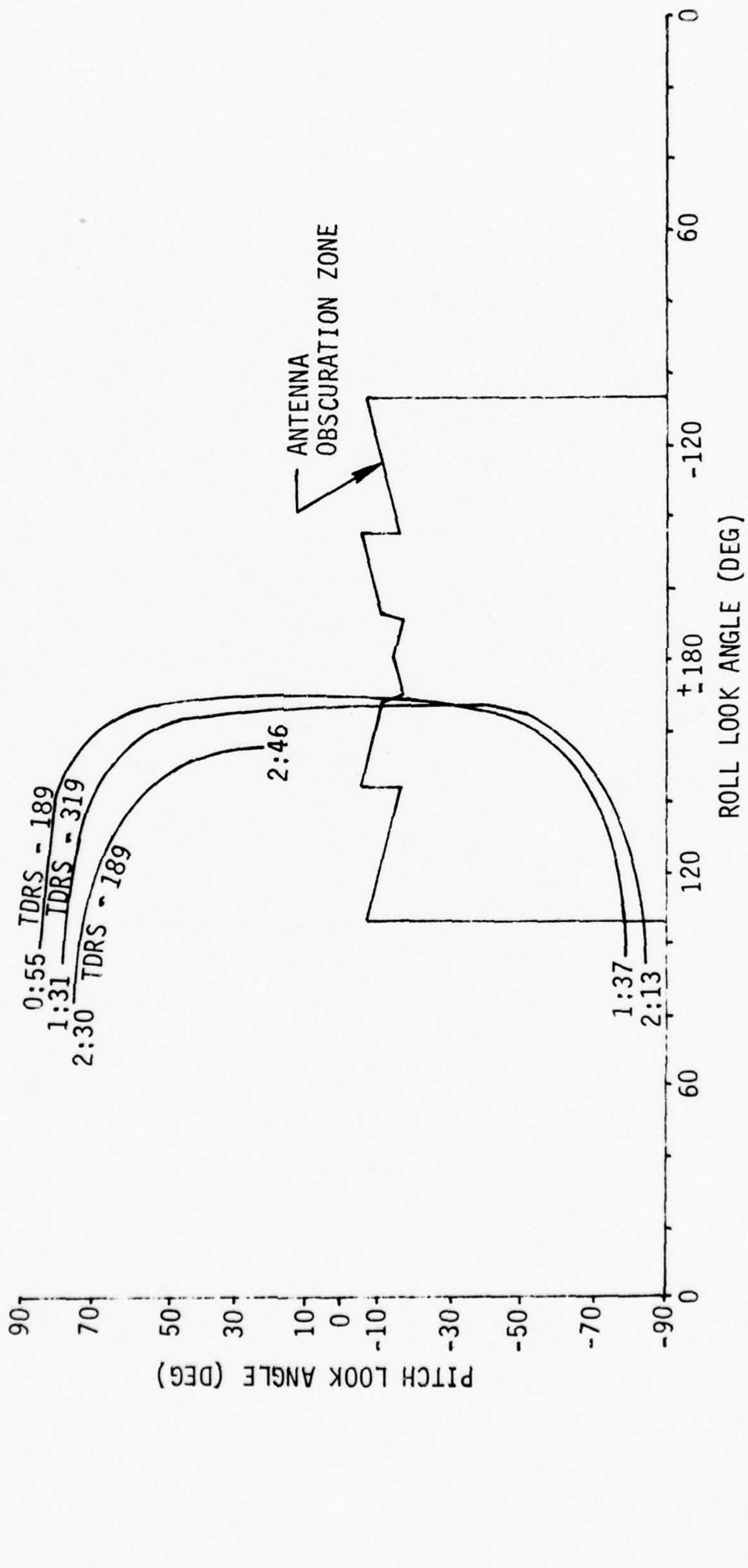

Figure 5-29. TDRS Look Angles Overlayed with Combined Antenna Obscuration Zone

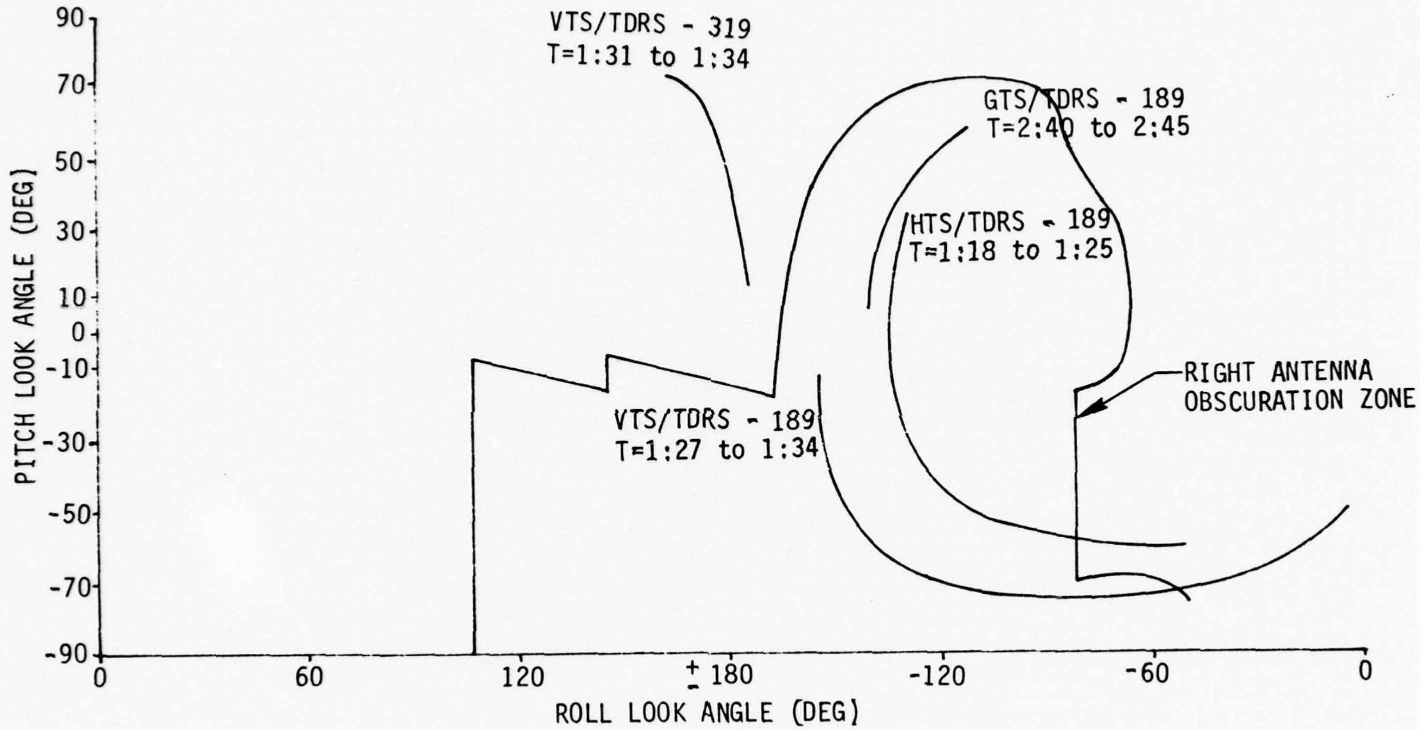

Figure 5-30. TDRS Look Angles with Orbiter Payload Bay Oriented to RTS Overlayed with Right Antenna Obscuration Zone

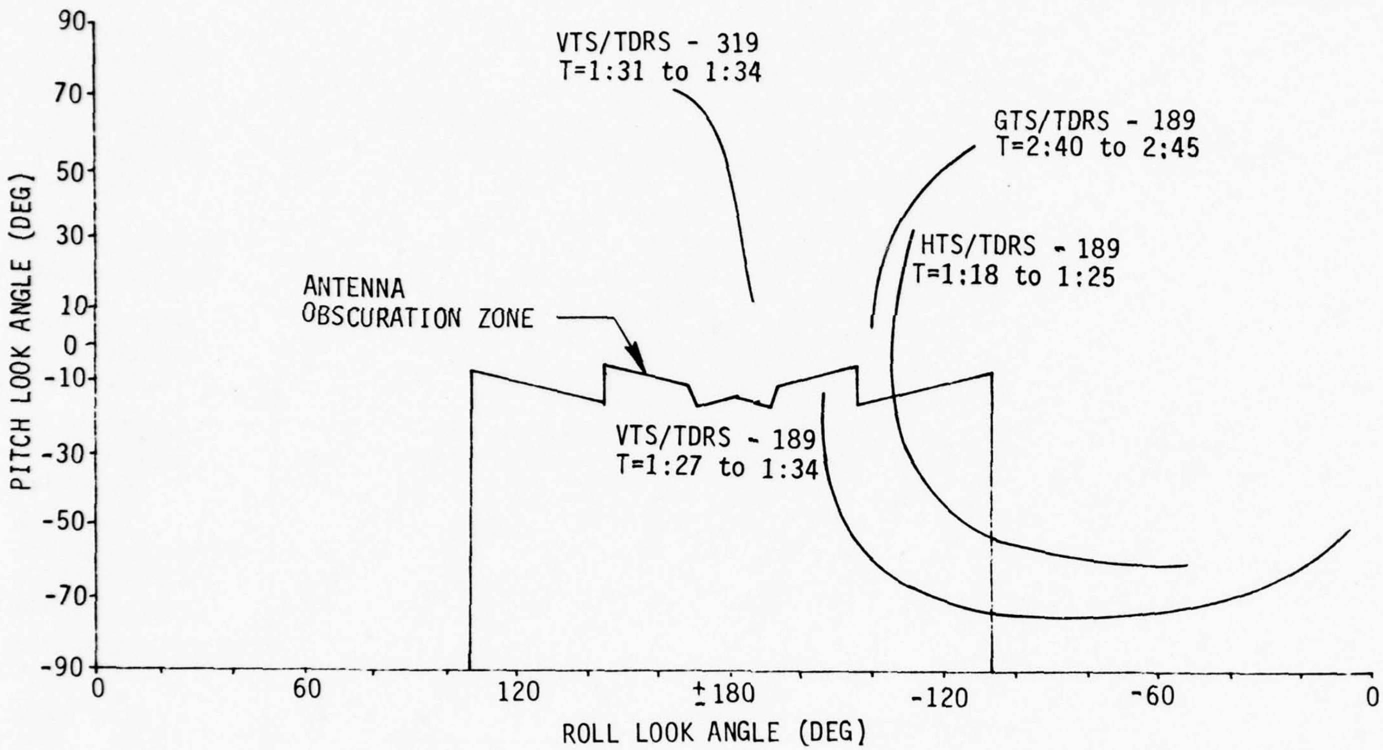

Figure 5-31. TDRS Look Angles with Orbiter Payload Bay Oriented to RTS Overlayed with Combined Antenna Obscuration Zone

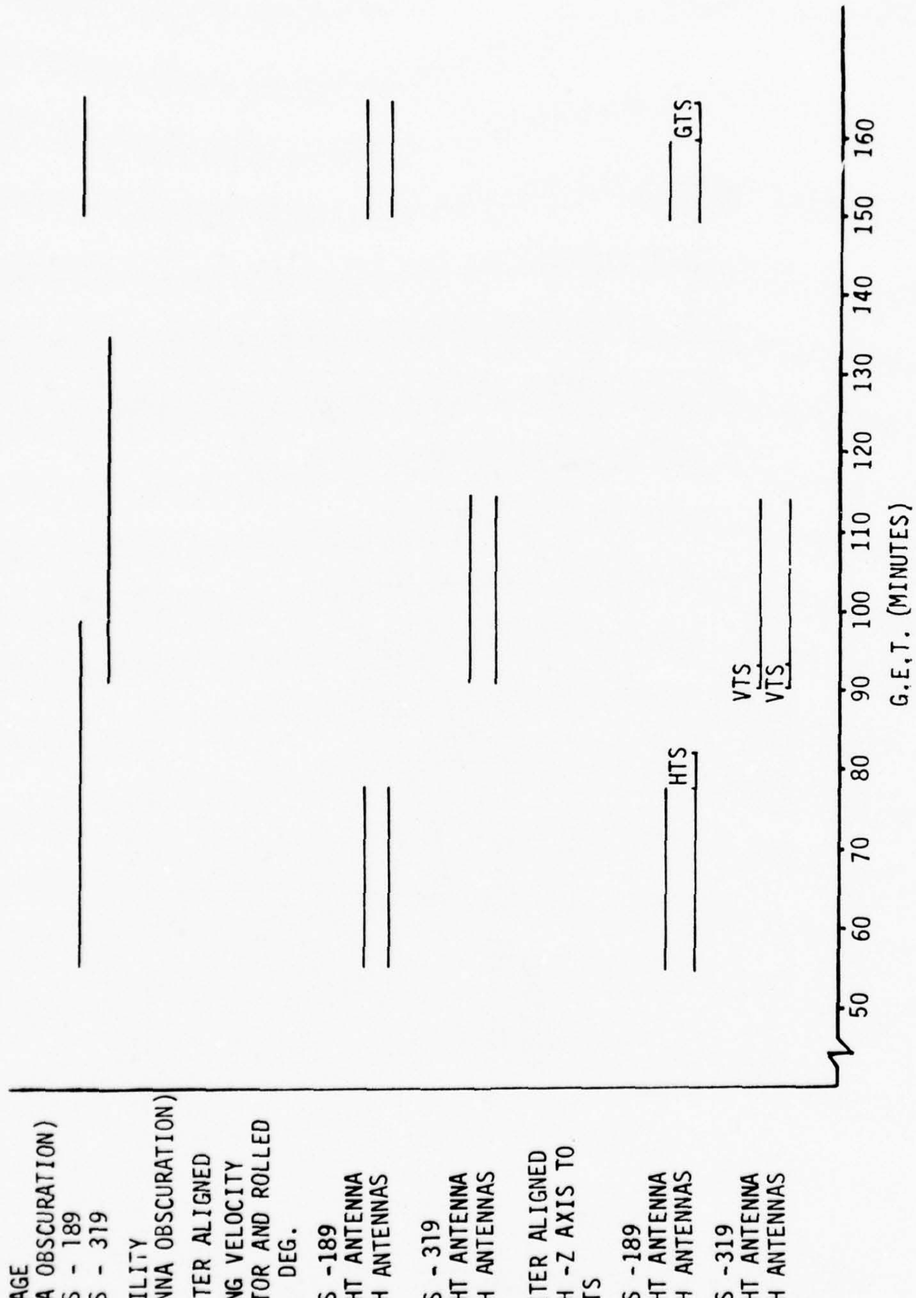

Figure 5-32. Mission A TDRS Coverage Summary

6. OTHER GEOSYNCHRONOUS PAYLOADS

Fleet Satellite Communications (FSC) is the only alternate payload for which data are available for Mission A planning purposes. Table 6-1 provides mission planning data which were used in assessing the differences between the FSC and DSP Missions. Analysis of the Orbiter Crew Activity timelines for each mission indicates that both missions may be flown in an almost identical manner. Both timelines show that the IUS transfer burn can occur at 05:45:06 GET. For the DSP and FSC missions, the RMS attachment and payload movement out of the payload bay is constrained to a nightpass. Additional DSP mission constraints (described in Section 3.2) impose a 45-minute launch window on the DSP mission.

Table 6-1. Mission Planning Data

Parameter	DSP	FSC
1. Launch Window Constraints (from KSC), min/day	45	None
2. Orbiter Earth Parking Orbit Objectives		
Apogee and Perigee Altitude, n.mi.	150	150
Inclination, deg	28.5	28.5
3. Total Payload Weight, lb	37,193	36,611
4. Deployed Payload Weight, lb	34,693	34,111
5. Payload Size		
Max. Length, in.	456	393.5
Max. Diameter, in.	116	116
6. Payload CG Position (In Payload Bay)		
X, in.	1112	1110 (Est.)
Y, in.	0.4	0.4 (Est.)
Z, in.	378.5	378.5 (Est.)
7. Satellite Orbit Design		
Apogee and Perigee, n.mi.	19,323	19,323
Inclination, deg	2.1	3
Right Ascension of Ascending Mode, deg	292	300
Longitude, deg	114 W(Typical)	TBD No Requirement
8. IUS Transfer Burn Data		
• Burn Position, Node	Fourth Ascending	Fourth Ascending
• Burn Window, hr:min GET	05:35 to 05:54	05:35 to 05:54
9. IUS/Status at Launch		
• IUS Receiver	ON	ON
• IUS Transmitter	OFF	OFF
10. Satellite Status at Launch		
• Transmitter	ON	TBD
• Receiver	ON	TBD
• Systems	TBD	TBD

Table 6-1. Mission Planning Data (Continued)

Parameter	DSP	FSC
11. Thermal Control Requirements		
• Open P/L Bay Doors, after launch (IUS Constraint), hr	0.5 to 1.5	0.5 to 1.5
• Maximum Direct Solar Illumination on Payload (Payload in Bay), min	20	30
• IUS Thermal Control Maneuver Required after Release, min	Within 20 (if in sunlight)	Within 5
• Orientation During IUS coast periods (before IUS/SAT Separation)	IUS longitudinal axis normal to solar vector within ±30 deg	IUS longitudinal axis normal to solar vector within ±30 deg
• Thermal Control Maneuver During IUS coast periods	Roll of >0.75 deg/sec with delays of up to 14 min (not to exceed 6 delays)	Roll of 3 to 6 deg/sec with delay not greater than 5 min.
12. Deployment Constraints		
• Payload Bay Sunlight	Attach RMS and deploy in darkness	Deploy in darkness
• Payload Telemetry Monitoring	3 minutes per RTS pass after P/L bay doors are opened	(TBD) minutes per RTS pass after P/L bay doors are opened
• IUS Transmitter Activation and Verification by RTS	After IUS is extended on RMS	After IUS is extended on RMS
13. Post Release Requirements		
• IUS RCS Enable (after Release) by an RTS after achieving safe separation distance (~200 ft), min.	Within 14	Within 5
• IUS Separation Burn (Contamination) ΔV Constraint, ft/sec	≤ 4	TBD
• Orbiter Circularization Burn after P/L Release, min	45 (after separation burn)	None Required
14. Return to Earth		
Deorbit Burn, hr:min:sec	20:13:32	20:13:32 (est.)
Landing at KSC, hr:min:sec	21:08:00	21:08:00 (est.)

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1. DOD Space Mission Model (U), (FY 1980-FY 1991), Rev. 6, 12 February 1976. (Secret).

2. Interim Upper Stage (IUS) Flight Operations/Mission Analysis, Boeing, October 1976.

3. IUS Baseline System and Interface Description, Boeing, September 1976.

4. Functional Flow Diagrams, Boeing Report D290-10070-1, 13 December 1977.

5. Department of Defense Spacecraft-to-Space Transportation System Interface Requirements for the Defense Support Program (DSP), SAMSO, January 1977.

6. Orbit Manual for Synchronous and Subsynchronous Satellites, G. S. Gedeon, TRW Report 99900-6310-RO-00, August 1967.

7. Space Shuttle System Baseline Reference Missions, Vol. I - Mission 1, Rev. 2, JSC-07896, 7 July 1975.

8. Ascent /Aborts Integrated Flight Procedures Handbook (Draft), JSC-10559, 31 October 1976.

9. Crew Activity Timeline (Draft), NASA/JSC, February 1977.

10. Orbiter Configuration Control OMS and RCS Propellant Budget-Rev. 1, JSC-09288 22 August 1975.

11. Mission Assessment Report - Operations Design Mission A, SAMSO -TR 75-261, 17 November 1975.

APPENDIX A:

CONFIGURATION SUMMARY

This Appendix summarizes the baseline configuration data used in this study.

A.1 ORBITER VEHICLE CHARACTERISTIC SUMMARY

A.1.1 Mass Properties

A.1.1.1 Solid Rocket Boosters		Reference
• Dry Weight (Burnout)	345,398 lb	A-1
• Propellant Weight	2,220,580 lb	A-2
• Total Weight (liftoff)	2,565,978	
A.1.1.2 External Tank Weight		
• Dry Weight	72,636 lb	A-1
• Propellant Weight (Ascent)	1,571,062 lb	A-1
• Total Weight (Liftoff)	1,643,698 lb	
A.1.1.3 Orbiter Vehicle		
• Orbiter Inert (without payload)	132,054 lb	A-1
• SSME (3) Inert	19,338 lb	A-1
• OMS Propellant	15,000 lb	A-1
• RCS Propellant	7,391 lb	A-1
• Non-Impulsive Consumables	3,579 lb	A-1
• Personnel (3)	1,983 lb	A-1
• Cable Air and H_2O Press.	191 lb	
• MPS	5,206 lb	A-1
• Total	184,642 lb	

A.1.1.4 Mission Payload		Reference
• DSP Satellite Weight	2,738 lb	A-3
• IUS Weight	31,955 lb	A-4
• Cradle Weight	2,500 lb	

A.1.2 Dimensions

A.1.2.1 Overall Dimensions

A.1.2.2 Orbiter Dimensions

• Length of Cargo Bay	60 ft	A-1
• Diameter of Cargo Bay	15 ft	A-1

A.1.3 Propulsion

A.1.3.1 Solid Rocket Booster

• Vacuum Thrust	Table A-1	
• Specific Impulse	Table A-1	

A.1.3.2 Main Propulsion System
(3 engines, each as described below)

• Sea level thrust	375,000 lb	A-1
• Vacuum thrust	470,000 lb	
• Sea level ISP	363.2	
• Vacuum ISP	455.2	
• Mixture ratio (oxidizer/fuel)	6.0	

- Throttleable from 50% to 109%
- Gimballed Nozzle: +10.5 Pitch, ±8.5 Yaw, Roll ±10.5 deg
- Operates in parallel with Solid Rocket Boosters from launch to SRB shutdown
- Fixed nozzle area ratio of 77.5:1

Table A-1. SRM (Single Motor) Performance at Nominal Propellent Mean Temperature (PMT) = 70°F

Time (S)	Vacuum Thrust (lb)	Vacuum ISP (S)
0.000	0	000.00
0.099	99457	256.48
0.197	828129	259.40
0.295	1900000	260.77
0.296	1915049	260.79
0.297	1928243	260.85
0.394	2539191	261.32
0.493	2776670	261.48
0.591	2857859	261.50
0.690	2884246	261.53
0.788	2892365	261.48
0.887	2893455	261.52
0.985	2902514	261.51
1.971	2926743	261.48
3.941	2991623	261.46
5.911	3057621	261.43
7.881	3092754	261.37
9.851	3114487	261.33
11.822	3133986	261.28
13.792	3153994	261.24
15.762	3174001	261.20
17.732	3191165	261.16
19.702	3208330	261.13
21.673	3190366	261.07
23.643	3000722	260.93
25.613	2913516	260.83
27.983	2839914	260.76
29.553	2771490	260.68
31.523	2710478	260.61
33.493	2652712	260.54
35.464	2596573	260.47

Table A-1. SRM (Single Motor) Performance at Nominal Propellent Mean Temperature (PMT) = 70°F (Continued)

Time (S)	Vacuum Thrust (lb)	Vacuum ISP (S)
37.434	2543782	260.40
39.404	2491499	260.33
41.374	2439825	260.26
43.344	2392923	260.20
45.314	2359118	260.14
47.284	2334045	260.09
49.255	2297193	260.04
51.225	2314559	260.02
53.195	2329182	260.00
55.165	2314667	259.97
57.135	2333758	259.96
59.105	2363612	259.96
61.075	2393871	259.95
63.045	2424131	259.95
65.015	2450633	259.94
66.985	2477746	259.94
68.956	2505773	259.93
70.926	2523341	259.91
72.896	2536849	259.90
74.866	2547108	259.88
76.836	2555640	259.86
78.806	2564173	259.84
80.776	2539403	259.80
82.746	2483463	259.73
84.716	2433716	259.68
86.686	2400824	259.62
88.656	2367017	259.55
90.626	2332804	259.47
92.596	2296967	259.39
94.566	2258185	259.31
96.536	2216357	259.22

Table A-1. SRM (Single Motor) Performance at Nominal Propellent Mean Temperature (PMT) = 70°F (Continued)

Time (S)	Vacuum Thrust (lb)	Vacuum ISP (S)
98.506	2163359	259.12
100.476	2110565	259.04
102.446	2061324	258.94
104.416	2013810	258.85
106.386	1961624	258.76
108.357	1908930	258.65
110.327	1854206	258.55
110.819	1812679	258.49
111.020	1793720	258.47
111.312	1766177	258.43
111.804	1694800	258.36
112.297	1606568	258.24
112.789	1520061	258.14
113.282	1417004	258.00
113.774	1286432	257.80
114.267	1150378	257.57
114.759	1027624	257.32
115.252	917379	257.10
115.744	816992	256.91
116.237	724424	256.71
116.729	638922	256.50
117.222	559157	256.29
117.714	477869	256.03
118.207	403679	255.76
118.699	337508	255.47
119.192	278863	255.16
119.684	228035	254.83
120.177	182629	254.48
120.669	119069	253.81
120.886	100000	253.49
121.162	75776	253.09

Table A-1. SRM (Single Motor) Performance at Nominal Propellent Mean Temperature (PMT) = 70°F (Concluded)

Time (S)	Vacuum Thrust (lb)	Vacuum ISP (S)
121.654	50303	252.45
122.147	31868	251.74
122.639	10246	250.95
123.132	11102	250.12

A.1.3.3 OMS Engines (2 engines)

		Reference
• Thrust (per engine)	6000 lb	A-1
• ISP	313.2 sec	
• Mixture ratio	1.65	

A.1.3.4 RCS Engines (44 engines 6 of which are vernier engines)

• Thrust (per main engine)	870 lb	
• Thrust (per vernier engine)	25 lb	
• I_{SP} (main engine)	289 sec	
• I_{SP} (vernier engine)	228 sec	
• Maximum duration of single firing	100 sec	
• Minimum duration of single firing	0.03 sec	

A.1.4 Aerodynamic Data

All Aerodynamic data were obtained from Reference A-5.

A.2 IUS VEHICLE CHARACTERISTICS SUMMARY

A.2.1 Mass Properties

• First Stage Weight	24,030 lb	A-4
• Second Stage Weight	7,925 lb	

A.2.2 Propulsion

• First Stage		A-4
• Thrust	42,600	
• ISP	290.28	
• Propellant Weight	21,571 lb	
• Second Stage		
• Thrust	17430.	
• ISP	294.55	
• Propellant Weight	6,056 lb	

A.3 RADAR STATION DATA

The type and locations of the radar tracking stations are given in Table A-2. In addition, two TDRS satellites at the following geostationary locations were used:

TDRS1: Lat = 0^o, Long = 189^oE

TDRS2: Lat = 0^o, Long = 319^oE

A.4 MAIN ENGINE PROPELLANT DUMP MODEL

Time from OMS-1 Ignition, sec	Dump Rate, lb/sec	Resultant Thrust, lb
0 - 165.48	29.7	270
165.48 - 175.48	0.0	0
175.48 - 219.59	6.6	120

Table A-2. Tracking Stations

Name DOD SCF Network	Geodetic Latitude, deg North	Longitude, deg East	Altitude, ft
NHS (Dual)	42.95	288.37	692
VTS (Dual)	34.82	239.50	1001
HTS (Dual)	21.57	201.74	942
IOS (Single)	-4.67	55.48	1936
GTS (Single)	13.61	144.85	528
TTS (Single)	76.52	291.48	466
TEL-4 (Single)	28.35	279.31	48

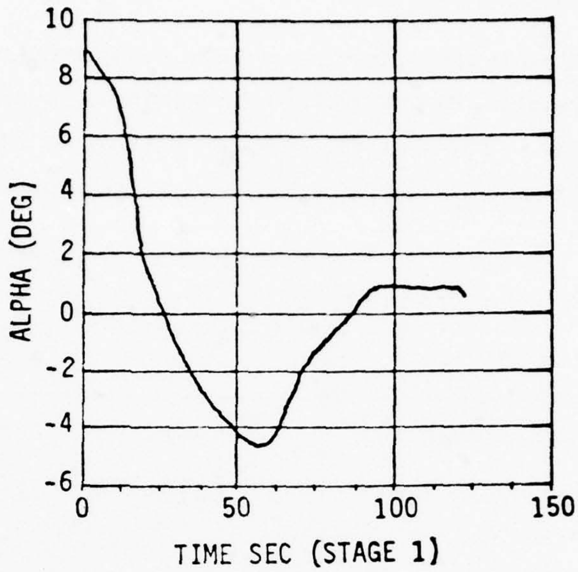

Figure A-1. Angle of Attack vs Time for Boost Phase for Propellant Mean Temperature = 70°F (Reference A-6)

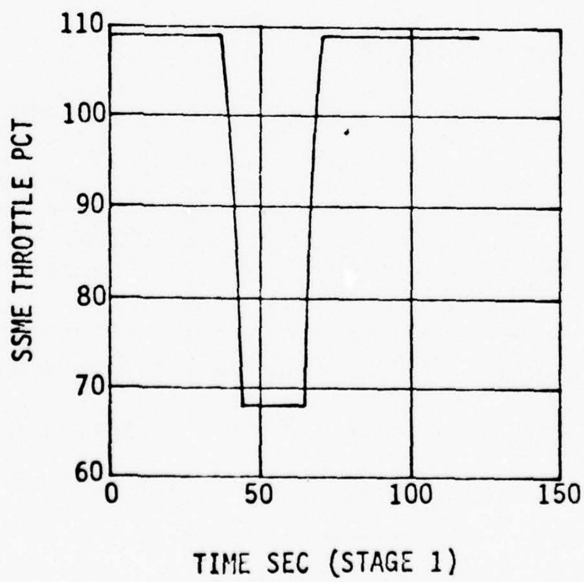

Figure A-2. First Stage SSME Throttle

A.5 LAUNCH SITES

Two launch sites have been designated to support the STS missions. The eastern site, at KSC, will support low and medium inclination orbit missions. The western site, at VAFB, will support polar and near-polar orbit missions. Table A-3 defines the launch site locations.

Tables A-3. Launch Sites

Site	Longitude, deg	Geod. Latitude, deg	Altitude*, ft
Eastern Pad 39A	80.60413 W	28.60842 N	47.6
(KSC) Pad 39B	80.621082 W	28.626880 N	52.6
Western Pad B (VAFB)	120.619694 W	34.565639 N	250

*Altitude of lowest end of booster above the reference ellipsoid; add ~ 100 ft to IMU location.

A.6 LANDING SITES

The STS landing sites are identified and described in Table A-4.

Table A-4. STS Landing Sites

Landing Site (Start of Runway)	Longitude, deg	GEOC. Latitude, deg	Altitude*, ft	True Runway Bearing, deg
Eastern (KSC)	80.70639 W	28.47095 N	42	150
Western (VAFB)	120.5650 W	34.54173 N	256	316
Edwards (EAFB)	117.8629 W	34.73770 N	2300	235

*Altitude above reference ellipsoid.

Table A-5. ETR MECO Target

MECO Target Conditions	
Altitude, n. mi.	60
Velocity, ft/sec	25668
Flight Path Angle, deg	0.5

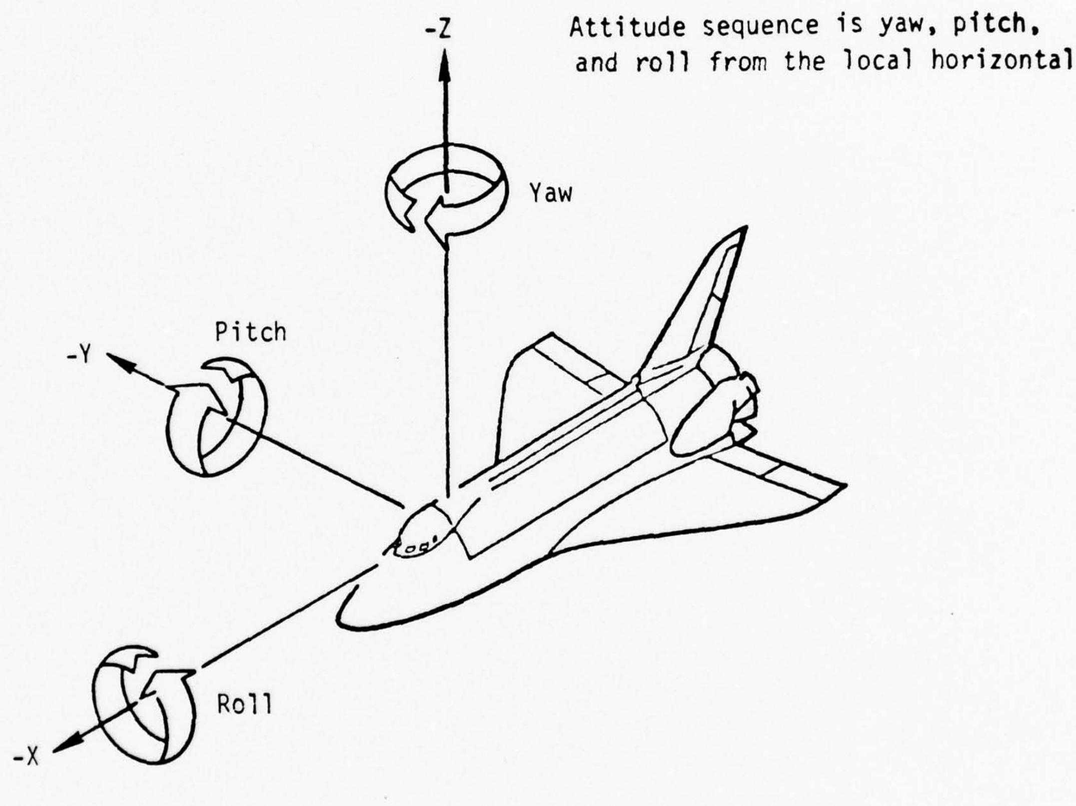

Figure A-3. Orbiter Coordinate System Definition

REFERENCES

A-1. Shuttle Operational Data Book, Volume II Mission Mass Properties, JSC-08934 Rev. A, September 1975.

A-2. Shuttle Operational Data Book, Volume I, Shuttle Systems Performance and Constraints Data, JSC-08934, June 1974.

A-3. DSP/Space Transportation System Transition Study Final Briefing, 16439-21-003-001, October 1976.

A-4. Interim Upper Stage (IUS) Flight Operations/Mission Analysis, Boeing, October 1976.

A-5. Space Shuttle Program, Aerodynamic Design Data Book, Volume II, Mated Vehicle, SD72-SH-0060-2H, February 1975.

APPENDIX B

REFERENCE TRAJECTORY LISTING

This appendix presents reference trajectory printouts for the nominal Operations Design Mission A ascent and on-orbit operations. On-orbit reference trajectories are included for each of three consecutive IUS first-burn opportunities following the nominal (third ascending node) opportunity.

Vehicle and propellant weight data in these printouts reflects only propellant used for translational maneuvers. Accurate propellant usage data must be obtained from Section 5.3 and used to adjust the weights shown in the reference trajectories.

The print mnemonics are defined in Section B.4.

B.1 Nominal Ascent

```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  10                          SVDS  2.3                            PAGE    1
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                  *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
1. INPUT VEHICLE POSITION  (FLAMB,PHID,HD)      = -.806041+02  .286084+02  .128000+03
2. INPUT VEHICLE VELOCITY  (VE,GAME,PSIE)       =  .000000     .000000    -.900000+02
3. INPUT VEHICLE ANG. VEL. (BODY RATES)         =  .000000     .000000     .000000
4. INPUT VEHICLE ORIENTATION - LAUNCH SITE ALINEMENT
5. INPUT VEHICLE PCS ALINEMENT - LAUNCH SITE ALINEMENT
FLAG(S)      VALUE     MODEL     DESCRIPTION
-------      -----     -----     -----------
IAEROF           3     ARO3S6    AERODYNAMICS SIMULATED FOR 3DOF
ISTAN           15     ATMSPL    1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
INGFLG           3     MAENG     MAIN ENGINE MODEL IS EXECUTED
MASVAR           1     VARMAS    VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

TIME      0.000000                     ROTATIONAL DYNAMICS DATA                      VEHICLE 1
 TPHASE  0.0000000   GMT      0   0    .000                 GET      0   0    .000
 FRX     4.4333807+06 FBY     0.0000000    FBZ    2.6032609+05 FMAG   4.4410172+06
 MBX     0.0000000   MBY      0.0000000    MBZ    0.0000000    MMAG   0.0000000
 OMEGX   0.0000000   OMEGY    0.0000000    OMEGZ  0.0000000    OMEGA  0.0000000
 OMEGXD  0.0000000   OMEGYD   0.0000000    OMEGZD 0.0000000    OMEGAD 0.0000000
 OGA     8.9999999+01 IGA     0.0000000    MGA    0.0000000
 OGAD    0.0000000   IGAD     0.0000000    MGAD   0.0000000

TIME      0.000000                       AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  0.0000000   GMT      0   0    .000                 GET      0   0    .000
 FBXA    0.0000000   FBYA     0.0000000    FBZA   0.0000000    MACH   0.0000000   ALPHA   0.0000000
 MBXA    0.0000000   MBYA     0.0000000    MBZA   0.0000000    QBAR   0.0000000   BETA    0.0000000
 LOD     0.0000000   CL       0.0000000    CD     1.0300000-01 LF     0.0000000   BANK    0.0000000

TIME      0.000000                       TRAJECTORY DATA                                        VEHICLE 1
 TPHASE  0.0000000   GMT      0   0    .000                 GET      0   0    .000
 XI      1.8385195+07 YI      0.0000000    ZI     9.9603214+06 RI     2.0909888+07 ALT    1.2724950+02
 XID     0.0000000   YID      1.3406696+03 ZID    0.0000000    VI     1.3406696+03 LATD   2.8608420+01
 XIDD   -9.4893765-01 YIDD    2.3945327-04 ZIDD   1.6687453+00 AI     1.9370966+00 LATC   2.8446962+01
 AZIE    0.0000000   AZII     9.0000001+01 GAME   0.0000000    GAMI   0.0000000   LONG  -8.0604129+01
 RGI     0.0000000   RGE      0.0000000    RGET   0.0000000    CRG    0.0000000   DRG     0.0000000
 XDE     0.0000000   YDE      0.0000000    ZDE    0.0000000    VE     0.0000000

TIME      0.000000                      ORBITAL ELEMENT DATA                         VEHICLE 1
TPHASE    0.000000
 A       1.0468920+07 ECC     9.9733005-01 INCL   2.8446962+01 ASC N  2.7000000+02 ARGPER 2.7000000+02
 MA      1.8000000+02 RREF    2.0925741+07 RP     2.7951443+04 RA     2.0909888+07 HP    -2.0897790+07
 HA     -1.5853750+04 HMAG    2.6033251+10 ENERGY -6.7229804+08 FA    1.8000000+02 TA     1.8000000+02
 PERIOD  1.7938487+03 DESC N  9.0000000+01 ARGLAT 4.5000000+02
```

B.1 Nominal Ascent (Continued)

```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  10                          SVDS  2.3                                PAGE   2
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                      VARIABLE OUTPUT
  TIMEC  0.0000000      XYZI  1.8385195+07    XYZI  0.0000000      XYZI  9.9603214+06     XID  0.0000000        YID  1.3406696+03
    ZID  0.0000000        VI  1.3406696+03  XYZDDS  2.7352312+01 XYZDDS -2.8468629-16  XYZDDS  1.7071013+01  XYZIDD -9.4893765-01
     GX -2.8301250+01     GY  2.3045327-04      GZ -1.5382268+01  SWGT6  1.5000000+04     IGA  0.0000000        MGA  0.0000000
    OGA  8.9999999+01    POR  0.0000000      PQR  0.0000000       PGR  0.0000000       BIJ  8.7791263-01       BIJ  0.0000000
    BIJ  4.7882057-01    BIJ -1.1102230-16     BIJ  1.0000000+00    BIJ  1.1102230-16     BIJ -4.7882087-01       BIJ -1.5062768-16
    BIJ  8.7791263-01    ALT  1.2724950+02   FBMAG  4.4410172+06   QBAR  0.0000000     RANGE  0.0000000         HA -2.6091916+00
     HP -3.4393339+03 ATSMG2  3.2242339+01   ALPHA  0.0000000     BETA  0.0000000      LATD  2.8608420+01     LONG -8.0604129+01
   GAMI  0.0000000      GAME  0.0000000       VE  0.0000000     VGNX  0.0000000      VGNY  0.0000000       VGNZ  0.0000000
   FBXA  0.0000000    ENG4TM  1.6052599+06  ENG9TM  0.0000000   ENG3TM  1.4419665+06      WT  4.4316109+06  XYZIDS  0.0000000
 XYZIDS  0.0000000    XYZIDS  0.0000000     AZII  9.0000001+01      TA  1.8000000+02    TTGO  0.0000000

TIME     6.037604+00                        ROTATIONAL DYNAMICS DATA                      VEHICLE 1
 TPHASE  6.0376039+00  GMT      0   0   6.038                     GET      0   0   6.038
 FBX     6.8246728+06  FBY     0.0000000     FBZ      2.6057737+05  FMAG    6.8298454+06
 MBX     0.0000000     MBY     0.0000000     MBZ      0.0000000     MMAG    0.0000000
 OMEGX   0.0000000     OMEGY   0.0000000     OMEGZ    0.0000000     OMEGA   0.0000000
 OMEGXD  0.0000000     OMEGYD  0.0000000     OMEGZD   0.0000000     OMEGAD  0.0000000
 OGA     8.9999999+01  IGA     0.0000000     MGA      0.0000000
 OGAD    0.0000000     IGAD    0.0000000     MGAD     0.0000000

TIME     6.037604+00                        AERODYNAMIC DATA                              VEHICLE 1
 TPHASE  6.0376039+00  GMT      0   0   6.038                     GET      0   0   6.038
 FBXA   -2.6242486+03  FBYA    0.0000000     FBZA    -3.0866436+02  MACH    8.9190171-02  ALPHA   6.7083129+00
 MBXA    0.0000000     MBYA    0.0000000     MBZA     0.0000000     QBAR    1.1621023+01  BETA   -3.0152524-02
 LOD     0.0000000     CL      0.0000000     CD       8.4483276-02  LF      0.0000000     BANK   -4.3569746-01

TIME     6.037604+00                        TRAJECTORY DATA                                              VEHICLE 1
 TPHASE  6.0376039+00  GMT      0   0   6.038                     GET      0   0   6.038
 XI      1.8385416+07  YI      8.0943606+03  ZI       9.9604825+06  RI      2.0910160+07  ALT     3.9999841+02
 XID     8.0535748+01  YID     1.3406334+03  ZID      5.7475984+01  VI      1.3442795+03  LATD    2.8608515+01
 XIDD    1.5832815+01  YIDD   -1.2228982-02  ZIDD     1.0921531+01  AI      1.9234293+01  LATC    2.8447059+01
 AZIE   -4.2415727-01  AZII    8.9491755+01  GAME     8.3130130+01  GAMI    4.2109622+00  LONG   -8.0604129+01
 RGI     0.0000000     RGE     0.0000000     RGET     0.0000000     CRG     0.0000000     DRG     0.0000000
 XDE     8.1125998+01  YDE    -5.2322388-02  ZDE      5.7475984+01  VE      9.9422928+01

TIME     6.037604+00                        ORBITAL ELEMENT DATA                          VEHICLE 1
TPHASE   6.037604+00
 A       1.0469132+07  ECC     9.9733011-01  INCL     2.8451220+01  ASC N   2.7109209+02  ARGPER  2.6907325+02
 MA      1.7938305+02  RREF    2.0925741+07  RP       2.7951385+04  RA      2.0910312+07  HP     -2.0897790+07
 HA     -1.5429500+04  HMAG    2.8033218+10  ENERGY  -6.7228442+08  EA      1.7969111+02  TA      1.7998871+02
 PERIOD  1.7939032+03  DESC N  9.1092093+01  ARGLAT   4.4906196+02
```

B.1 Nominal Ascent (Continued)

```
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  10                       SVDS  2.3                                  PAGE    3
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                    VARIABLE OUTPUT
  TIMEC  6.0376039+00    XYZI  1.8385416+07    XYZI  8.0943606+03    XYZI  9.9604825+06     XID  8.0535748+01     YID  1.3406334+03
    ZID  5.7475984+01      VI  1.3442795+03 XYZDDS  4.4133296+01 XYZDDS -2.9525769-16 XYZDDS  2.6303444+01 XYZIDD  1.5832815+01
     GX -2.8300492+01      GY -1.2228982-02      GZ -1.5381913+01   SWGT6  1.5000000+04     IGA  0.0000000      MGA  0.0000000
    OGA  8.9999999+01     PDR  0.0000000      PGR  0.0000000      PGR  0.0000000      BIJ  8.7791263-01     BIJ  0.0000000
    BIJ  4.7882087-01     BIJ -1.1102230-16     BIJ  1.0000000+00     BIJ  1.1102230-16     BIJ -4.7882087-01     BIJ -1.5062768-16
    BIJ  8.7791263-01     ALT  3.9999841+02  FBMAG  6.8324795+06    QBAR  1.1621023+01   RANGE  0.0000000       HA -2.5393690+00
     HP -3.4393339+03  ATSMG2  5.1377222+01  ALPHA  6.7083128+00    BETA -3.0152524-02    LATD  2.8608515+01    LONG -8.0604129+01
   GAMI  4.2109622+00    GAME  8.3130130+01      VE  9.9422928+01    VGNX  0.0000000     VGNY  0.0000000     VGNZ  0.0000000
   FRXA -2.6242486+03  ENG4TM  2.6030123+06 ENG9TM  0.0000000    ENG3TM  1.4428642+06      WT  4.2770661+06 XYZIDS  2.5140604+02
 XYZIDS -1.7492980-15  XYZIDS  1.5034735+02    AZII  8.9491755+01      TA  1.7998871+02    TTGO  0.0000000
```

B.1 Nominal Ascent (Continued)

```
-------------------------------------------------------------------------------------------
CASE  1  PHASE  20                          SVDS  2.3                               PAGE    5
-------------------------------------------------------------------------------------------

                                   *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE      MODEL     DESCRIPTION
-------      -----      -----     -----------
ISTEER         3        STEER     OPEN LOOP STEERING, PERFORM TABLE LOOKUP ON GIMBAL ANGLES
IAEROF         3        ARO3S6    AERODYNAMICS SIMULATED FOR 3DOF
ISTAN         15        ATMSPL    1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR           1        AZTTAR    FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         4        MAENG     MAIN ENGINE MODEL IS EXECUTED
MASVAR         1        VARMAS    VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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TIME       6.037604+00                       ROTATIONAL DYNAMICS DATA                    VEHICLE 1
 TPHASE  0.0000000    GMT        0   0   6.038                     GET       0   0   6.038
 FRX     6.8248728+06  FRY      0.0000000    FRZ      2.6057737+05  FMAG    6.8298454+06
 MRX     0.0000000    MRY      0.0000000    MRZ      0.0000000     MMAG    0.0000000
 OMEGX   0.0000000    OMEGY    0.0000000    OMEGZ    0.0000000     OMEGA   0.0000000
 OMEGXD  0.0000000    OMEGYD   0.0000000    OMEGZD   0.0000000     OMEGAD  0.0000000
 OGA     8.9999999+01  IGA      0.0000000    MGA      0.0000000
 OGAD    0.0000000    IGAD     0.0000000    MGAD     0.0000000

TIME       6.037604+00                       AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  0.0000000    GMT        0   0   6.038                     GET       0   0   6.038
 FBXA   -2.6242486+03  FBYA     0.0000000    FBZA    -3.0866436+02  MACH    8.9190171-02  ALPHA    6.7083128+00
 MBXA    0.0000000    MBYA     0.0000000    MBZA     0.0000000     QBAR    1.1621023+01  BETA    -3.0152524-02
 LOD     0.0000000    CL       0.0000000    CD       8.4483276-02  LF      0.0000000     BANK    -4.3569746-01

TIME       6.037604+00                       TRAJECTORY DATA                                          VEHICLE 1
 TPHASE  0.0000000    GMT        0   0   6.038                     GET       0   0   6.038
 XI      1.8385416+07  YI       8.0943606+03  ZI       9.9604825+06  RI      2.0910160+07  ALT      3.9999841+02
 XID     8.0535746+01  YID      1.3406334+03  ZID      5.7475984+01  VI      1.3442795+03  LATD     2.8608515+01
 XIDD    1.5832815+01  YIDD    -1.2228982-02  ZIDD     1.0921531+01  AI      1.9234293+01  LATC     2.8447059+01
 AZIE   -4.2415797-01  AZII     8.9491755+01  GAME     8.3130130+01  GAMI    4.2109622+00  LONG    -8.0604129+01
 RGI     0.0000000    RGE      0.0000000    RGET     0.0000000     CRG     0.0000000     DRG      0.0000000
 XDE     8.11.5998+01  YDE     -5.2322388-02  ZDE      5.7475984+01  VE      9.9422928+01

TIME       6.037604+00                       ORBITAL ELEMENT DATA                        VEHICLE 1
TPHASE     0.000000
 A       1.0469132+07  ECC      9.9733011-01  INCL     2.8451220+01  ASC N   2.7109209+02  ARGPER   2.6907325+02
 MA      1.7936305+02  RREF     2.0925741+07  RP       2.7951385+04  RA      2.0910312+07  HP      -2.0897790+07
 HA     -1.5429500+04  HMAG     2.8033218+10  ENERGY  -6.7228442+08  EA      1.7969111+02  TA       1.7998871+02
 PERIOD  1.7939032+03  DESC N   9.1092093+01  ARGLAT   4.4906196+02
```

B.1 Nominal Ascent (Continued)

CASE 1 PHASE 20 SVDS 2.3 PAGE 6

VARIABLE OUTPUT

TIMEC	6.0376039+00	XYZI	1.8385416+07	XYZI	8.0943606+03	XYZI	9.9604825+06	XID	8.0535748+01	YID	1.3406334+03
ZID	5.7475984+01	VI	1.3442795+03	XYZDDS	4.4133296+01	XYZDDS	-2.9525769-16	XYZDDS	2.6303444+01	XYZIDD	1.5832815+01
GX	-2.8300482+01	GY	-4.2228982-02	GZ	-1.5381913+01	SWGT6	1.5000000+04	IGA	0.0000000	MGA	0.0000000
OGA	8.9999999+01	PQR	0.0000000	PQR	0.0000000	PQR	0.0000000	BIJ	8.7791263-01	BIJ	0.0000000
BIJ	4.7882087-01	BIJ	-1.1102230-16	BIJ	1.0000000+00	BIJ	1.1102230-16	BIJ	-4.7882087-01	BIJ	-1.5062768-16
BIJ	8.7791263-01	ALT	3.9999841+02	FBMAG	6.8324725+06	OBAR	1.1621023+01	RANGE	5.7299354-03	HA	-2.5393690+00
HP	-3.4393339+03	ATSMG2	5.1377222+01	ALPHA	6.7083128+00	BETA	-3.3152524-02	LATD	2.8608515+01	LONG	-8.0604129+01
GAMI	4.2109622+00	GAME	8.3130130+01	VE	9.9422908+01	VGNX	0.0000000	VGNY	0.0000000	VGNZ	0.0000000
FBXA	-2.6242486+03	ENG4TM	2.8030123+06	ENG9TM	0.0000000	ENG3TM	1.4428642+06	WT	4.2770661+06	XYZIDS	2.5140604+02
XYZIDS	-1.7492980-15	XYZIDS	1.5034735+02	AZII	8.9491755+01	TA	1.7998871+02	TTGO	0.0000000		

TIME 1.603760+01 ROTATIONAL DYNAMICS DATA VEHICLE 1

TPHASE	1.0000000+01	GMT	0 0 16.038			GET	0 0 16.038
FBX	7.0806837+06	FBY	0.0000000	FBZ	2.6402491+05	FMAG	7.0856044+06
MBX	0.0000000	MBY	0.0000000	MBZ	0.0000000	MMAG	0.0000000
OMEGX	0.0000000	OMEGY	0.0000000	OMEGZ	0.0000000	OMEGA	0.0000000
OMEGXD	0.0000000	OMEGYD	0.0000000	OMEGZD	0.0000000	OMEGAD	0.0000000
OGA	1.5975003+02	IGA	-8.5999997+00	MGA	2.1344341-07		
OGAD	0.0000000	IGAD	0.0000000	MGAD	0.0000000		

TIME 1.603760+01 AERODYNAMIC DATA VEHICLE 1

TPHASE	1.0000000+01	GMT	0 0 16.038			GET	0 0 16.038		
FBXA	-3.1360929+04	FBYA	0.0000000	FBZA	-9.2473512+02	MACH	2.9143303-01	ALPHA	1.6889829+00
MBXA	0.0000000	MBYA	0.0000000	MBZA	0.0000000	OBAR	1.1548039+02	BETA	4.7139359+00
LOD	0.0000000	CL	0.0000000	CD	1.0094760-01	LF	0.0000000	BANK	1.2886954+02

TIME 1.603760+01 TRAJECTORY DATA VEHICLE 1

TPHASE	1.0000000+01	GMT	0 0 16.038			GET	0 0 16.038		
XI	1.8387097+07	YI	2.1694950+04	ZI	9.9616424+06	RI	2.0912200+07	ALT	2.4399903+03
XID	2.6376784+02	YID	1.3891295+03	ZID	1.7678050+02	VI	1.4249581+03	LATD	2.8609089+01
XIDD	2.1000089+01	YIDD	6.5063884+00	ZIDD	1.2343011+01	AI	2.5212829+01	LATC	2.8447646+01
AZIE	5.8859412+01	AZII	8.8803495+01	GAME	7.9983436+01	GAMI	1.2877225+01	LONG	-8.0603531+01
RGI	0.0000000	RGE	0.0000000	RGET	0.0000000	CRG	0.0000000	DRG	0.0000000
XDE	2.6534986+02	YDE	4.8321304+01	ZDE	1.7678050+02	VE	3.2248540+02		

TIME 1.603760+01 ORBITAL ELEMENT DATA VEHICLE 1

TPHASE	1.0000000+01								
A	1.0471894+07	ECC	9.9713349-01	INCL	2.8470696+01	ASC N	2.7257814+02	ARGPER	2.6783041+02
MA	1.7801497+02	RREF	2.0925741+07	RP	3.0017910+04	RA	2.0913771+07	HP	-2.0895724+07
HA	-1.1970500+04	HMAG	2.9049561+10	ENERGY	-6.7210706+08	EA	1.7900604+02	TA	1.7996234+02
PERIOD	1.7946134+03	DESC N	9.2578148+01	ARGLAT	4.4779276+02				

B.1 Nominal Ascent (Continued)

CASE 1 PHASE 20 SVDS 2.3 PAGE 7

VARIABLE OUTPUT

TIMEC	1.6037604+01	XYZI	1.8387097+07	XYZI	2.1694950+04	XYZI	9.9616424+06	XID	2.6376784+02	YID	1.3891295+03
ZID	1.7678050+02	VI	1.4249581+03	XYZDDS	4.9294878+01	XYZDDS	6.5395427+00	XYZDDS	2.7722205+01	XYZIDD	2.1000089+01
GX	-2.8244789+01	GY	-3.3154366-02	GZ	-1.5379194+01	SWGT6	1.5000000+04	IGA	-8.5999997+00	MGA	2.1344341-07
OGA	1.5975000+02	POR	0.0000000	PGR	0.0000000	POR	0.0000000	BIJ	8.6804170-01	BIJ	1.4953534-01
BIJ	4.7343719-01	BIJ	-4.9466347-01	BIJ	3.4222548-01	BIJ	7.9886778-01	BIJ	-4.2563312-02	BIJ	-9.2764264-01
BIJ	3.7103566-01	ALT	2.4399903+03	FBMAG	7.1169780+06	QBAR	1.1548039+02	RANGE	5.1139791-02	HA	-1.9700909+00
HP	-3.4389938+03	ATSMG2	5.6932162+01	ALPHA	1.6889829+00	BETA	4.7139359+00	LATD	2.8600089+01	LONG	-8.0603531+01
GAMI	1.2877225+01	GAME	7.9983436+01	VE	3.2246540+02	VGNX	0.0000000	VGNY	0.0000000	VGNZ	0.0000000
FBXA	-3.1360929+04	ENG4TM	2.9507722+06	ENG9TM	0.0000000	ENG3TM	1.4493791+06	WT	4.0042846+06	XYZIDS	7.1761948+02
XYZIDS	4.8722427+01	XYZIDS	4.2345987+02	AZII	8.8803495+01	TA	1.7996234+02	TTGO	0.0000000		

B.1 Nominal Ascent (Continued)

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-------------------------------------------------------------------------------------------
CASE  1  PHASE  30                       SVDS  2.3                              PAGE   9
-------------------------------------------------------------------------------------------

                                   *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***

TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE     MODEL     DESCRIPTION
-------      -----     -----     -----------
ISTEER         1       STEER     OPEN LOOP STEERING WITH GRAVITY TURN IS EXECUTED, VEHICLE THRUSTS ALONG THE
IGTURN         2                 EARTH RELATIVE VELOCITY VECTOR PROJECTED INTO XZ EARTH-CENTERED PLUMBLINE PLANE
IAEROF         3       AR03S6    AERODYNAMICS SIMULATED FOR 3DOF
ISTAN         15       ATMSPL    1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR           1       AZTTAR    FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         4       MAENG     MAIN ENGINE MODEL IS EXECUTED
MASVAR         1       VARMAS    VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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                                   ROTATIONAL DYNAMICS DATA                          VEHICLE 1
TIME      1.603760+01
 TPHASE  0.0000000      GMT       0   0  16.038                    GET     0   0  16.038
 FEX     7.0806837+06   FBY      0.0000000     FBZ     2.6402491+05  FMAG   7.0856044+06
 MBX     0.0000000      MBY      0.0000000     MBZ     0.0000000     MMAG   0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000     OMEGZ   0.0000000     OMEGA  0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000     OMEGZD  0.0000000     OMEGAD 0.0000000
 OGA     1.5975000+02   IGA     -8.5999997+00  MGA     2.1344341-07
 OGAD    0.0000000      IGAD     0.0000000     MGAD    0.0000000

                                   AERODYNAMIC DATA                                  VEHICLE 1
TIME      1.603760+01
 TPHASE  0.0000000      GMT       0   0  16.038                    GET     0   0  16.038
 FBXA   -3.1360929+04   FBYA     0.0000000     FBZA   -9.2473512+02  MACH   2.9143303-01  ALPHA  1.6889829+00
 MBXA    0.0000000      MBYA     0.0000000     MBZA    0.0000000     QBAR   1.1548039+02  BETA   4.7139359+00
 LOD     0.0000000      CL       0.0000000     CD      1.0094760-01  LF     0.0000000     BANK   1.2886954+02

                                   TRAJECTORY DATA                                                      VEHICLE 1
TIME      1.603760+01
 TPHASE  0.0000000      GMT       0   0  16.038                    GET     0   0  16.038
 XI      1.8387097+07   YI       2.1694950+04  ZI      9.9616424+06  RI     2.0912200+07  ALT    2.4399903+03
 XID     2.6376784+02   YID      1.3991295+03  ZID     1.7673050+02  VI     1.4249581+03  LATD   2.8609089+01
 XIDD    2.1000089+01   YIDD     6.5063884+00  ZIDD    1.2343011+01  AI     2.5212829+01  LATC   2.8447646+01
 AZIE    5.8859412+01   AZII     8.2903495+01  GAME    7.9983436+01  GAMI   1.2877225+01  LONG  -8.0603531+01
 RGI     0.0000000      RGE      0.0000000     RGET    0.0000000     CRG    0.0000000     DRG    0.0000000
 XDE     2.6534986+02   YDE      4.8321304+01  ZDE     1.7678050+02  VE     3.2248540+02

                                   ORBITAL ELEMENT DATA                              VEHICLE 1
TIME      1.603760+01
TPHASE    0.000000
 A       1.0471394+07   ECC      9.9713349-01  INCL    2.8470696+01  ASC N  2.7257814+02  ARGPER  2.6783041+02
 MA      1.7801497+02   RREF     2.0925741+07  RP      3.0017910+04  RA     2.0913771+07  HP     -2.0895724+07
 HA     -1.1970500+04   HMAG     2.9049561+10  ENERGY -6.7210706+08  FA     1.7900604+02  TA      1.7996234+02
 PERIOD  1.7946134+03   DESC N   9.2578148+01  ARGLAT  4.4779276+02
```

B. 1 Nominal Ascent (Continued)

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CASE  1  PHASE  30                          SVDS  2.3                                 PAGE   10

                                    VARIABLE OUTPUT
  TIMEC  1.6037604+01   XYZI  1.8387097+07   XYZI  2.1694950+04   XYZI  9.9616424+06     XID  2.6376784+02     YID  1.3891295+03
    ZID  1.7678050+02     VI  1.4249581+03 XYZDDS  4.9294878+01 XYZDDS  6.5395427+00 XYZDDS  2.7722205+01  XYZIDD  2.1000089+01
     GX -2.8294789+01     GY -3.3154366-02     GZ -1.5379194+01  SWGT6  1.5000000+04     IGA -8.5999997+00     MGA  2.1344341-07
    OGA  1.5975000+02    PQR  0.0000000     PQR  0.0000000       PQR  0.0000000       BIJ  8.6804170-01     BIJ  1.4953534-01
    BIJ  4.7343719-01    BIJ -4.9466347-01    BIJ  3.4222548-01    BIJ  7.9886778-01    BIJ -4.2563312-02     BIJ -9.2764264-01
    BIJ  3.7103566-01    ALT  2.4399903+03  FBMAG  7.1169780+06   QBAR  1.1548039+02   RANGE  5.1139791-02      HA -1.9700909+00
     HP -3.4389938+03 ATSMG2  5.6932162+01  ALPHA  1.6889829+00   BETA  4.7139359+00    LATD  2.8609089+01    LONG -8.0603531+01
   GAMI  1.2877225+01   GAME  7.9983436+01     VF  3.2248540+02   VGNX  0.0000000      VGNY  0.0000000      VGNZ  0.0000000
   FBXA -3.1360929+04 ENG4TM  2.9507722+06 ENG9TM  0.0000000   ENG3TM  1.4493791+06      WT  4.0042846+06  XYZIDS  7.1761948+02
 XYZIDS  4.8722427+01 XYZIDS  4.2345987+02   AZII  8.8803495+01     TA  1.7996234+02    TTGO  0.0000000
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  30                         SVDS  2.3                                    PAGE   19
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

TIME      1.155677+02                      ROTATIONAL DYNAMICS DATA                    VEHICLE 1
 TPHASE  9.9530094+01  GMT      0   1  55.568                    GET      0   1  55.568
 FBX     3.1906493+06  FBY     0.0000000    FBZ     3.1863374+05 FMAG    3.2065204+06
 MBX     0.0000000     MBY     0.0000000    MBZ     0.0000000    MMAG    0.0000000
 OMEGX   0.0000000     OMEGY   0.0000000    OMEGZ   0.0000000    OMEGA   0.0000000
 OMEGXD  0.0000000     OMEGYD  0.0000000    OMEGZD  0.0000000    OMEGAD  0.0000000
 OGA     1.7936256+02  IGA    -5.8005387+01 MGA     3.2016512-07
 OGAD    0.0000000     IGAD    0.0000000    MGAD    0.0000000

TIME      1.155677+02                      AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  9.9530094+01  GMT      0   1  55.568                    GET      0   1  55.568
 FBXA   -4.2540277+04  FBYA    0.0000000    FBZA   -7.4563019+02 MACH    4.1678807+00 ALPHA   1.0041564+00
 MBXA    0.0000000     MBYA    0.0000000    MBZA    0.0000000    QBAR    6.9267764+01 BETA    3.6811687-01
 LOD     0.0000000     CL      0.0000000    CD      2.2822460-01 LF      0.0000000    BANK    1.7892812+02

TIME      1.155785+02                      ROTATIONAL DYNAMICS DATA                    VEHICLE 1
 TPHASE  9.9540857+01  GMT      0   1  55.578                    GET      0   1  55.578
 FBX     3.1862753+06  FBY     0.0000000    FBZ     3.1863459+05 FMAG    3.2021677+06
 MBX     0.0000000     MBY     0.0000000    MBZ     0.0000000    MMAG    0.0000000
 OMEGX   0.0000000     OMEGY   0.0000000    OMEGZ   0.0000000    OMEGA   0.0000000
 OMEGXD  0.0000000     OMEGYD  0.0000000    OMEGZD  0.0000000    OMEGAD  0.0000000
 OGA     1.7936257+02  IGA    -5.8008467+01 MGA     2.1344341-07
 OGAD    0.0000000     IGAD    0.0000000    MGAD    0.0000000

TIME      1.155785+02                      AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  9.9540857+01  GMT      0   1  55.578                    GET      0   1  55.578
 FBXA   -4.2501194+04  FBYA    0.0000000    FBZA   -7.4494508+02 MACH    4.1681162+00 ALPHA   1.0041562+00
 MBXA    0.0000000     MBYA    0.0000000    MBZA    0.0000000    QBAR    6.9205091+01 BETA    3.6807399-01
 LOD     0.0000000     CL      0.0000000    CD      2.2822142-01 LF      0.0000000    BANK    1.7892819+02

TIME      1.155788+02                      ROTATIONAL DYNAMICS DATA                    VEHICLE 1
 TPHASE  9.9541208+01  GMT      0   1  55.579                    GET      0   1  55.579
 FBX     3.1861331+06  FBY     0.0000000    FBZ     3.1863462+05 FMAG    3.2020262+06
 MBX     0.0000000     MBY     0.0000000    MBZ     0.0000000    MMAG    0.0000000
 OMEGX   0.0000000     OMEGY   0.0000000    OMEGZ   0.0000000    OMEGA   0.0000000
 OMEGXD  0.0000000     OMEGYD  0.0000000    OMEGZD  0.0000000    OMEGAD  0.0000000
 OGA     1.7936257+02  IGA    -5.8008566+01 MGA     3.2016512-07
 OGAD    0.0000000     IGAD    0.0000000    MGAD    0.0000000

TIME      1.155788+02                      AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  9.9541208+01  GMT      0   1  55.579                    GET      0   1  55.579
 FBXA   -4.2499617+04  FBYA    0.0000000    FBZA   -7.4491671+02 MACH    4.1681229+00 ALPHA   1.0041553+00
 MBXA    0.0000000     MBYA    0.0000000    MBZA    0.0000000    QBAR    6.9202549+01 BETA    3.6807276-01
 LOD     0.0000000     CL      0.0000000    CD      2.2822133-01 LF      0.0000000    BANK    1.7892819+02

TIME      1.155788+02                      TRAJECTORY DATA                                          VEHICLE 1
 TPHASE  9.9541208+01  GMT      0   1  55.579                    GET      0   1  55.579
 XI      1.8499095+07  YI      2.8094756+05 ZI      1.0026578+07 RI      2.1043468+07 ALT     1.3371497+05
 XID     2.0277968+03  YID     4.9668362+03 ZID     1.1496650+03 VI      5.4866339+03 LATD    2.8615559+01
 XIDD    1.8865369+00  YIDD    4.3573499+01 ZIDD    1.1466560+00 AI      4.3629476+01 LATC    2.8455096+01
 AZIE    8.9859963+01  AZII    8.9898244+01 GAME    3.3754235+01 GAMI    2.5901569+01 LONG   -8.0216934+01
 RGI     0.0000000     RGE     0.0000000    RGET    0.0000000    CRG     0.0000000    DRG     0.0000000
 XDE     2.0442838+03  YDE     3.6178613+03 ZDE     1.1496650+03 VE      4.3134807+03
```

B.1 Nominal Ascent (Continued)

CASE 1 PHASE 30 SVDS 2.3 PAGE 20

ORBITAL ELEMENT DATA — VEHICLE 1

TIME	1.155788+02								
TPHASE	9.954121+01								
A	1.0763935+07	ECC	9.6374709-01	INCL	2.8455263+01	ASC N	2.7108365+02	ARGPER	2.7086360+02
MA	1.6484988+02	RREF	2.0925741+07	RP	3.9022404+05	RA	2.1137646+07	HP	-2.0535517+07
HA	2.1190500+05	HMAG	1.0385958+11	ENERGY	-6.5387183+08	EA	1.7227361+02	TA	1.7894864+02
PERIOD	1.8702068+03	DESC N	9.1083652+01	ARGLAT	4.4981224+02				

VARIABLE OUTPUT

TIMEC	1.1557881+02	XYZI	1.8499090+07	XYZI	2.8094756+05	XYZI	1.0026578+07	XID	2.0277968+03	YID	4.9668362+03
ZID	1.1496650+03	VI	5.4866339+03	XYZDDS	2.9826317+01	XYZDDS	4.3997565+01	XYZDDS	1.6337646+01	XYZIDD	1.8885369+00
GX	-2.7937760+01	GY	-4.2406624-01	GZ	-1.5190990+01	SWGT6	1.5000000+04	IGA	-5.8006566+01	MGA	3.2016512-07
OGA	1.7936257+02	PQR	0.0000000	PQR	0.0000000	PQR	0.0000000	BIJ	4.6511151-01	BIJ	8.4812730-01
BIJ	2.5367571-01	BIJ	-4.8707426-01	BIJ	5.8949439-03	BIJ	8.7334067-01	BIJ	7.3920866-01	BIJ	-5.2975971-01
BIJ	4.1584278-01	ALT	1.3371497+05	FBMAG	3.2443908+06	QBAR	6.9202549+01	RANGE	2.0435907+01	HA	3.4875077+01
HP	-3.3797115+03	ATSMG2	5.5608574+01	ALPHA	1.0041553+00	BETA	3.6807276-01	LATD	2.8615559+01	LONG	-8.0216934+01
GAMI	2.5901569+01	GAME	3.3754235+01	VE	4.3134807+03	VGNX	0.0000000	VGNY	0.0000000	VGNZ	0.0000000
FBXA	-4.2499617+04	ENG4TM	8.5678592+05	ENG9TM	0.0000000	ENG5TM	1.5366436+06	WT	1.8526306+06	XYZIDS	5.2849308+03
XYZIDS	3.6449522+03	XYZIDS	2.9203969+03	AZII	8.9898244+01	TA	1.7894864+02	TTGO	0.0000000		

B.1 Nominal Ascent (Continued)

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CASE  1  PHASE  40                          SVDS  2.3                                  PAGE  22

                                  *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE     MODEL     DESCRIPTION
-------      -----     -----     -----------
IAEROF         3       ARO3S6    AERODYNAMICS SIMULATED FOR 3DOF
ISTAN         15       ATMSPL    1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR           1       AZITAR    FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         3       MAENG     MAIN ENGINE MODEL IS EXECUTED
KTHROT         4       THROTL    VEHICLE IS TO BE THROTTLED
MASVAR         1       VARMAS    VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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TIME     1.155788+02                        ROTATIONAL DYNAMICS DATA                     VEHICLE 1
 TPHASE  0.0000000      GMT      0   1  55.579                      GET      0   1  55.579
 FRX     1.4718436+06   FRY      0.0000000      FRZ     3.1881846+05  FMAG   1.5059776+06
 MRX     0.0000000      MRY      0.0000000      MRZ     0.0000000     MMAG   0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000      OMEGZ   0.0000000     OMEGA  0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000      OMEGZD  0.0000000     OMEGAD 0.0000000
 OGA     1.7936257+02   IGA     -5.8008566+01   MGA     3.2016512-07
 OGAD    0.0000000      IGAD     0.0000000      MGAD    0.0000000

TIME     1.155788+02                          AERODYNAMIC DATA                           VEHICLE 1
 TPHASE  0.0000000      GMT      0   1  55.579                      GET      0   1  55.579
 FRXA   -3.1991231+04   FRYA     0.0000000      FRZA   -5.6072982+02  MACH   4.1681229+00   ALPHA   1.0041553+00
 MRXA    0.0000000      MRYA     0.0000000      MRZA    0.0000000     QBAR   6.9202549+01   BETA    3.6807276-01
 LOD     0.0000000      CL       0.0000000      CD      1.7179169-01  LF     0.0000000      BANK    1.7892819+02

TIME     1.155788+02                          TRAJECTORY DATA                                              VEHICLE 1
 TPHASE  0.0000000      GMT      0   1  55.579                      GET      0   1  55.579
 XI      1.8499090+07   YI       2.8094756+05   ZI      1.0026578+07  RI     2.1043468+07   ALT     1.3371497+05
 XID     2.0277968+03   YID      4.9668362+03   ZID     1.1496650+03  VI     5.4866339+03   LATD    2.8615559+01
 XIDD   -8.2938313+00   YIDD     2.2617570+01   ZIDD   -4.3907737+00  AI     2.4487160+01   LATC    2.8455096+01
 AZIE    8.9859963+01   AZII     8.9898244+01   GAME    3.3754235+01  GAMI   2.5901569+01   LONG   -8.0216934+01
 RGI     0.0000000      RGE      0.0000000      RGET    0.0000000     CRG    0.0000000      DRG     0.0000000
 XDE     2.0482838+03   YDE      3.6178613+03   ZDE     1.1496650+03  VE     4.3134807+03

TIME     1.155788+02                        ORBITAL ELEMENT DATA                         VEHICLE 1
TPHASE   0.000000
 A       1.0763935+07   ECC      9.6374709-01   INCL    2.8455263+01  ASC N  2.7108365+02   ARGPER  2.7086360+02
 MA      1.6484988+02   RREF     2.0025741+07   RP      3.9022404+05  RA     2.1137646+07   HP     -2.0535517+07
 HA      2.1190500+05   HMAG     1.0385958+11   ENERGY -6.5387183+08  EA     1.7227361+02   TA      1.7894864+02
 PERIOD  1.8702068+03   DESC N   9.1083652+01   ARGLAT  4.4981224+02
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B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  40                                 SVDS  2.3                                       PAGE   23
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                              VARIABLE OUTPUT
  TIMEC  1.1557681+02    XYZI  1.8499090+07    XYZI  2.8094756+05    XYZI  1.0026578+07     XID  2.0277968+03     YID  4.9668362+03
    ZID  1.1496650+03      VI  5.4866739+03  XYZDDS  1.9643949+01  XYZDDS  2.3041636+01  XYZDDS  1.0800216+01  XYZIDD -8.2938313+00
     GX -2.7937780+01      GY -4.2406624-01      GZ -1.5190990+01   SWGT6  1.5000000+04     IGA -5.8008566+01     MGA  3.2016512-07
    OGA  1.7936257+02     PQR  0.0000000      PQR  0.0000000      POR  0.0000000      BIJ  4.6511151-01     BIJ  8.4812730-01
    BIJ  2.5367571-01     BIJ -4.8727426-01     BIJ  5.8949439-03     BIJ  8.7334067-01     BIJ  7.3920866-01     BIJ -5.2975971-01
    BIJ  4.1564278-01     ALT  1.3371497+05   FBMAG  1.5373751+06    QBAR  6.9202549+01   RANGE  2.0435907+01      HA  3.4875077+01
     HP -3.3797115+03  ATSMG2  3.2147260+01   ALPHA  1.0041553+00    BETA  3.6807276-01    LATD  2.8615559+01    LONG -8.0216934+01
   GAMI  2.5901569+01    GAME  3.3754235+01      VE  4.3134807+03    VGNX  3.7844972+03    VGNY  5.4059278+01    VGNZ  2.1649577+04
   FBXA -3.1991231+04  ENG4TM  0.0000000   ENG9TM  0.0000000   ENG3TM  5.1204303+05      WT  1.5072326+06  XYZIDS  0.0000000
 XYZIDS  0.0000000   XYZIDS  0.0000000     AZII  8.9898244+01      TA  1.7894864+02    TTGO  3.8569260+02
TIME        2.3500000+02                    ROTATIONAL DYNAMICS DATA                     VEHICLE 1
 TPHASE   1.9421119+02   GMT        0   3  55.000                   GET         0   3  55.000
 FBX      1.5042015+06   FBY      0.0000000      FBZ       3.1953968+05   FMAG     1.5377671+06
 MBX      0.0000000      MBY      0.0000000      MBZ       0.0000000      MMAG     0.0000000
 OMEGX    0.0000000      OMEGY    0.0000000      OMEGZ     0.0000000      OMEGA    0.0000000
 OMEGXD   0.0000000      OMEGYD   0.0000000      OMEGZD    0.0000000      OMEGAD   0.0000000
 OGA      1.7932833+02   IGA     -8.2830902+01   MGA       8.6348914-02
 OGAD     0.0000000      IGAD     0.0000000      MGAD      0.0000000
```

B.1 Nominal Ascent (Continued)

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--------------------------------------------------------------------------------------------
CASE  1  PHASE  40                          SVDS  2.3                             PAGE   33
--------------------------------------------------------------------------------------------

TIME       2.350000+02                     AERODYNAMIC DATA                         VEHICLE 1
 TPHASE  1.1942119+02  GMT     0   3  55.000                  GET     0   3  55.000
 FBXA   -1.1801852+01  FBYA    0.0000000    FBZA    5.7412280-01  MACH   8.0264070+00  ALPHA  -2.7850631+00
 MBXA    0.0000000     MBYA    0.0000000    MBZA    0.0000000     QBAR   2.4115461-02  BETA    2.1444418-01
 LOD     0.0000000     CL      0.0000000    CD      1.8205159-01  LF     0.0000000     BANK    1.7918534+02

TIME       2.350000+02                     TRAJECTORY DATA                                      VEHICLE 1
 TPHASE  1.1942119+02  GMT     0   3  55.000                  GET     0   3  55.000
 XI      1.8647641+07  YI      1.0964789+06  ZI      1.0113738+07  RI     2.1242045+07  ALT     3.3226795+05
 XID     4.2447798+02  YID     8.9628032+03  ZID     2.8959123+02  VI     8.9775210+03  LATD    2.8591105+01
 XIDD   -1.4488383+01  YIDD    4.0736176+01  ZIDD   -7.8163012+00  AI     4.3936817+01  LATC    2.8432225+01
 AZIE    9.1497026+01  AZII    9.1268564+01  GAME    7.3323053+00  GAMI   6.2230635+00  LONG   -7.8220867+01
 RGI     0.0000000     RGE     0.0000000     RGET    0.0000000     CRG    0.0000000     DRG     0.0000000
 XDE     5.0443448+02  YDE     7.6029958+03  ZDE     2.8959123+02  VE     7.6252123+03

TIME       2.350000+02                     ORBITAL ELEMENT DATA                     VEHICLE 1
TPHASE     1.194212+02
 A       1.1308723+07  ECC     8.7990379-01  INCL    2.8458150+01  ASC N  2.7070221+02  ARGPER  2.7319496+02
 MA      1.7365571+02  RREF    2.0925741+07  RP      1.3581347+06  RA     2.1259310+07  HP     -1.9567607+07
 HA      3.3356900+05  HMAG    1.8957719+11  ENERGY -6.2237216+08  EA     1.7662429+02  TA      1.7914655+02
 PERIOD  2.0139716+03  DESC N  9.0702214+01  ARGLAT  4.5234151+02

                                           VARIABLE OUTPUT
  TIMEC  2.3500000+02    XYZI  1.8647641+07    XYZI  1.0964789+06    XYZI  1.0113738+07     XID  4.2447798+02     YID  8.9628032+03
    ZID  2.8959123+02      VI  8.9775210+03  XYZDDS  1.2891516+01  XYZDDS  4.2345879+01  XYZDDS  7.0802469+00  XYZIDD -1.4488383+01
     GX -2.7379899+01      GY -1.6097025+00      GZ -1.4896548+01   SWGT6  1.5000000+04     IGA -8.2838902+01     MGA  8.6348914-02
    OGA  1.7932333+02     PQR  0.0000000        PQR  0.0000000        PQR  0.0000000        BIJ  1.1016172-01     BIJ  9.9219845-01
    BIJ  5.8366492-02     BIJ -4.8883340-01     BIJ  2.9583530-03     BIJ  8.7237215-01     BIJ  8.6539362-01     BIJ -1.2463350-01
    BIJ  4.8534564-01     ALT  3.3226795+05   FBMAG  1.5377786+06    QBAR  2.4115461-02   RANGE  1.2577629+02      HA  5.4898396+01
     HP -3.2204138+03  ATSMG2  4.4827385+01   ALPHA -2.7850631+00    BETA  2.1444418-01    LATD  2.8591105+01    LONG -7.8220867+01
   GAMI  6.2230635+00    GAME  7.3323053+00      VE  7.6252123+03    VGNX  1.1813176+03    VGNY  5.5923947+01    VGNZ  1.7146561+04
   FBXA -1.1801852+01  ENG4TM  0.0000000     ENG9TM  0.0000000     ENG3TM  5.1229942+05      WT  1.1037047+06  XYZIDS  1.6957247+03
 XYZIDS  4.1107811+03  XYZIDS  9.3427148+02    AZII  9.1268564+01      TA  1.7914655+02    TTGO  0.0000000
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  50                          SVDS  2.3                                  PAGE   35
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                              *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE      MODEL      DESCRIPTION
-------      -----      -----      -----------
IAEROF         3        AR0356     AERODYNAMICS SIMULATED FOR 3DOF
ISTAM         15        ATMSPL     1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR           1        AZTTAR     FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         3        MAENG      MAIN ENGINE MODEL IS EXECUTED
KTHROT         4        THROTL     VEHICLE IS TO BE THROTTLED
MASVAR         1        VARMAS     VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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TIME       2.350000+02                       ROTATIONAL DYNAMICS DATA                    VEHICLE 1
 TPHASE  0.0000000   GMT      0   3  55.000                    GET     0   3  55.000
 FBX     1.3800747+06 FBY     0.0000000    FBZ     2.9315571+05 FMAG    1.4108673+06
 MBX     0.0000000   MBY      0.0000000    MBZ     0.0000000   MMAG    0.0000000
 OMEGX   0.0000000   OMEGY    0.0000000    OMEGZ   0.0000000   OMEGA   0.0000000
 OMEGXD  0.0000000   OMEGYD   0.0000000    OMEGZD  0.0000000   OMEGAD  0.0000000
 OGA     1.7932833+02 IGA    -8.2838902+01 MGA     8.6348914-02
 OGAD    0.0000000   IGAD     0.0000000    MGAD    0.0000000

TIME       2.350000+02                       AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  0.0000000   GMT      0   3  55.000                    GET     0   3  55.000
 FBXA   -1.1801852+01 FBYA    0.0000000    FBZA    5.7412280-01 MACH    8.0264070+00 ALPHA  -2.7850631+00
 MBXA    0.0000000   MBYA     0.0000000    MBZA    0.0000000   QBAR    2.4115461-02 BETA    2.1444418-01
 LCD     0.0000000   CL       0.0000000    CD      1.8205159-01 LF      0.0000000   BANK    1.7918534+02

TIME       2.350000+02                       TRAJECTORY DATA                                         VEHICLE 1
 TPHASE  0.0000000   GMT      0   3  55.000                    GET     0   3  55.000
 XI      1.8647641+07 YI      1.0964789+06 ZI      1.0113738+07 RI      2.1242045+07 ALT     3.3226795+05
 XID     4.2447798+02 YID     8.9628032+03 ZID     2.8959123+02 VI      8.9775210+03 LATD    2.8591105+01
 XIDD   -1.5552584+01 YIDD    3.7241848+01 ZIDD   -8.4007834+00 AI      4.1223916+01 LATC    2.8432225+01
 AZIE    9.1497026+01 AZII    9.1268564+01 GAME    7.3323053+00 GAMI    6.2230635+00 LONG   -7.8220867+01
 RGI     0.0000000   RGE      0.0000000    RGET    0.0000000   CRG     0.0000000   DRG     0.0000000
 XDE     5.0443448+02 YDE     7.6029958+03 ZDE     2.8959123+02 VE      7.6252123+03

TIME       2.350000+02                       ORBITAL ELEMENT DATA                        VEHICLE 1
TPHASE     0.000000
 A       1.1308723+07 ECC     8.7990379-01 INCL    2.8458150+01 ASC N   2.7070221+02 ARGPER  2.7319496+02
 MA      1.7365571+02 RREF    2.0925741+07 RP      1.3581347+06 RA      2.1259310+07 HP     -1.9567607+07
 HA      3.3356900+05 HMAG    1.8957719+11 ENERGY -6.2237216+08 EA      1.7662429+02 TA      1.7914655+02
 PERIOD  2.0139716+03 DESC N  9.0702214+01 ARGLAT  4.5234151+02
```

B. 1 Nominal Ascent (Continued)

CASE 1 PHASE 50 SVDS 2.3 PAGE 36

VARIABLE OUTPUT

TIMEC	2.3500000+02	XYZI	1.8647641+07	XYZI	1.0964789+06	XYZI	1.0113738+07	XID	4.2447798+02
ZID	2.8959123+02	VI	8.9775210+03	XYZDDS	1.1827316+01	XYZDDS	3.3851551+01	XYZDDS	6.4957647+00
GX	-2.7379899+01	GY	-1.6097025+00	GZ	-1.4896548+01	SWGT6	1.5000000+04	IGA	-8.2838902+01
OGA	1.7932833+02	PQR	0.0000000	PQR	0.0000000	PQR	0.0000000	BIJ	1.1016172-01
BIJ	5.8366492-02	BIJ	-4.8883346-01	BIJ	2.9583530-03	BIJ	8.7237215-01	BIJ	8.6539362-01
BIJ	4.8534564-01	ALT	3.3226795+05	FBMAG	1.4106787+06	QBAR	2.4115461-02	RANGE	1.2577629+02
HP	-3.2204138+03	ATSMG2	4.1128133+01	ALPHA	-2.7850631+00	BETA	2.1444418-01	LATD	2.8591105+01
GAMI	6.2230635+00	GAME	7.3323053+00	VE	7.6252123+03	VGNX	1.5604793+03	VGNY	5.6887452+01
FBXA	-1.1801852+01	ENG4TM	0.0000000	ENG9TM	0.0000000	ENG3TM	4.6999947+05	WT	1.1037047+06
XYZIDS	4.1107811+03	XYZIDS	9.3427148+02	AZII	9.1268564+01	TA	1.7914655+02	TTGO	2.6159569+02

YID	8.9628032+03
XYZIDD	-1.5552504+01
MGA	8.6348914-02
BIJ	9.9219645-01
BIJ	-1.2463350-01
HA	5.4898396+01
LONG	-7.8220867+01
VGNZ	1.7263311+04
XYZIDS	1.6957247+03

ROTATIONAL DYNAMICS DATA VEHICLE 1

TIME	4.891123+02						
TPHASE	2.5411033+02	GMT	0 8 9.110			GET	0 8 9.110
FBX	9.9176197+05	FBY	0.0000000	FBZ	2.1061945+05	FMAG	1.0139994+06
MBX	0.0000000	MBY	0.0000000	MBZ	0.0000000	MMAG	0.0000000
OMEGX	0.0000000	OMEGY	0.0000000	OMEGZ	0.0000000	OMEGA	0.0000000
OMEGXD	0.0000000	OMEGYD	0.0000000	OMEGZD	0.0000000	OMEGAD	0.0000000
OGA	1.7948231+02	IGA	-1.0962130+02	MGA	4.9515657-01		
OGAD	0.0000000	IGAD	0.0000000	MGAD	0.0000000		

B.1 Nominal Ascent (Continued)

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CASE  1  PHASE  50                          SVDS  2.3                              PAGE   58
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TIME      4.891103+02                        AERODYNAMIC DATA                  VEHICLE 1
 TPHASE  2.5411033+02  GMT      0   8   9.110                 GET      0   8   9.110
 FBXA   -9.8185799+00  FBYA     0.0000000    FBZA   -1.0983382+00  MACH   2.1132540+01  ALPHA    6.3827568+00
 MBXA    0.0000000     MBYA     0.0000000    MBZA    0.0000000     QBAR   2.6225014-02  BETA     4.3359452-02
 LOD     0.0000000     CL       0.0000000    CD      1.3997805-01  LF     0.0000000     BANK     1.7932875+02

TIME      4.891103+02                        TRAJECTORY DATA                                             VEHICLE 1
 TPHASE  2.5411033+02  GMT      0   8   9.110                 GET      0   8   9.110
 XI      1.8172790+07  YI       5.0662088+06  ZI      9.8670161+06  RI     2.1290250+07  ALT      3.7963583+05
 XID    -5.1763406+03  YID      2.4983026+04  ZID    -2.8107910+03  VI     2.5668007+04  LATD     2.7765611+01
 XIDD   -3.7422185+01  YIDD     8.7994646+01  ZIDD   -2.1111453+01  AI     9.7924312+01  LATC     2.7610106+01
 AZIE    9.7778044+01  AZII     9.7362428+01  GAME    5.2779915-01  GAMI   4.9975811-01  LONG    -6.7070266+01
 RGI     0.0000000     RGE      0.0000000     RGET    0.0000000     CRG    0.0000000     DRG      0.0000000
 XDE    -4.8069069+03  YDE      2.3657845+04  ZDE    -2.8107910+03  VE     2.4304331+04

TIME      4.891103+02                     ORBITAL ELEMENT DATA                 VEHICLE 1
TPHASE    2.541103+02
 A       2.1215707+07  ECC      9.4033575-03  INCL    2.8500117+01  ASC N   2.6999893+02  ARGPER  3.5132711+02
 MA      1.1144132+02  RREF     2.0925741+07  RP      2.1016208+07  RA      2.1415205+07  HP      9.0466750+04
 HA      4.8946400+05  HMAG     5.4645752+11  ENERGY -3.3174639+08  EA      1.1194107+02  TA      1.1243995+02
 PERIOD  5.1751063+03  DESC N   8.9998929+01  APGLAT  4.6376706+02

                                          VARIABLE OUTPUT
  TIMEC  4.8911033+02    XYZI  1.8172790+07    XYZI  5.0662088+06    XYZI  9.8670161+06     XID -5.1763406+03     YID  2.4983026+04
    ZID -2.8107910+03      VI  2.5668007+04  XYZDDS -1.0917682+01  XYZDDS  9.5383279+01  XYZDDS -6.6755324+00  XYZIDD -3.7422185+01
     GX -2.6504504+01      GY -7.3886329+00      GZ -1.4435920+01   SWGT6  1.5000000+04     IGA -1.0962130+02     MGA  4.9515657-01
    CGA  1.7948231+02     PQR  0.0000000      PQR  0.0000000      PQR  0.0000000      BIJ -2.9065557-01     BIJ  9.4189753-01
    BIJ -1.6836977-01     BIJ -4.8880322-01     BIJ  5.1076685-03     BIJ  8.7237912-01     BIJ  8.2255171-01     BIJ  3.3586153-01
    BIJ  4.5891798-01     ALT  3.7963583+05   FBMAG  1.0139092+06    QBAR  2.6225014-02   RANGE  7.1799130+02      HA  8.0555412+01
     HP  1.4896912+01  ATSMG2  9.6237872+01   ALPHA  6.3827568+00    BETA  4.3359452-02    LATD  2.7765611+01    LONG -6.7070266+01
   GAMI  4.9975611-01    GAME  5.2779915-01      VE  2.4304331+04    VGNX -1.7407089-03    VGNY  7.9170391-03    VGNZ  2.6687622-02
   FBXA -9.8185799+00  ENG4TM  0.0000000    ENG9TM  0.0000000    ENG3TM  3.3767630+05      WT  3.3896477+05  XYZIDS  2.9646587+03
 XYZIDS  2.1148621+04  XYZIDS  1.5738985+03    AZII  9.7362428+01      TA  1.1243995+02    TTGO  0.0000000
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B.1 Nominal Ascent (Continued)


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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  65                            SVDS  2.3                                    PAGE   60
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                         *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE     MODEL      DESCRIPTION
-------      -----     -----      -----------
IAEROF         3       ARO356     AERODYNAMICS SIMULATED FOR 3DOF
ISTAN         15       ATMSPL     1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAF           1       AZTIAR     FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         4       MAENG      MAIN ENGINE MODEL IS EXECUTED
KTHROT         4       THROTL     VEHICLE IS TO BE THROTTLED
MASVAR         1       VARMAS     VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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TIME      4.891103+02                         ROTATIONAL DYNAMICS DATA                       VEHICLE 1
 TPHASE  0.0000000      GMT        0   8   9.110                          GET        0   8   9.110
 FBX    -9.8185799+00   FBY       0.0000000      FBZ     -1.0983382+00   FMAG     9.8798207+00
 MBX     0.0000000      MBY       0.0000000      MBZ      0.0000000      MMAG     0.0000000
 OMEGX   0.0000000      OMEGY     0.0000000      OMEGZ    0.0000000      OMEGA    0.0000000
 OMEGXD  0.0000000      OMEGYD    0.0000000      OMEGZD   0.0000000      OMEGAD   0.0000000
 OGA     1.7948231+02   IGA      -1.0962130+02   MGA      4.9515657-01
 OGAD    0.0000000      IGAD      0.0000000      MGAD     0.0000000

TIME      4.891103+02                            AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  0.0000000      GMT        0   8   9.110                          GET        0   8   9.110
 FBXA   -9.8185799+00   FBYA      0.0000000      FBZA    -1.0983382+00   MACH     2.1132540+01   ALPHA    6.3827568+00
 MBXA    0.0000000      MBYA      0.0000000      MBZA     0.0000000      QBAR     2.6225014-02   BETA     4.3359452-02
 LOD     0.0000000      CL        0.0000000      CD       1.3997805-01   LF       0.0000000      BANK     1.7932875+02

TIME      4.891103+02                            TRAJECTORY DATA                                                  VEHICLE 1
 TPHASE  0.0000000      GMT        0   8   9.110                          GET        0   8   9.110
 XI      1.6172790+07   YI        5.0662088+06   ZI       9.8670161+06   RI       2.1290250+07   ALT      3.7963583+05
 XID    -5.1763406+03   YID       2.4983026+04   ZID     -2.8107910+03   VI       2.5668007+04   LATD     2.7765611+01
 XIDD   -2.6504319+01   YIDD     -7.3895457+00   ZIDD    -1.4435812+01   AI       3.1072125+01   LATC     2.7610106+01
 AZIE    9.7776044+01   AZII      9.7362428+01   GAME     5.2779915-01   GAMI     4.9975811-01   LONG    -6.7070266+01
 RGI     0.0000000      RGE       0.0000000      RGET     0.0000000      CRG      0.0000000      DRG      0.0000000
 XDE    -4.8069069+03   YDE       2.3657845+04   ZDE     -2.8107910+03   VE       2.4304331+04

TIME      4.891103+02                          ORBITAL ELEMENT DATA                          VEHICLE 1
TPHASE    0.0000000
 A       2.1215707+07   ECC       9.4033575-03   INCL     2.8500117+01   ASC N    2.6999893+02   ARGPER   3.5132711+02
 MA      1.1144132+02   RREF      2.0925741+07   RP       2.1016208+07   RA       2.1415205+07   HP       9.0466750+04
 HA      4.6946400+05   HMAG      5.4645752+11   ENERGY  -3.3174639+08   EA       1.1194107+02   TA       1.1243995+02
 PERIOD  5.1751063+03   DESC N    8.9998929+01   ARGLAT   4.6376706+02
```

B.1 Nominal Ascent (Continued)

CASE 1 PHASE 65 SVDS 2.3 PAGE 61

VARIABLE OUTPUT

TIMEC	4.8911033+02	XYZI	1.8172790+07	XYZI	5.0662088+06	XYZI	9.8670161+06	XID	-5.1763406+03	YID	2.4983026+04
ZID	-2.8107910+03	VI	2.5660097+04	XYZDDS	1.8512774-04	XYZDDS	-9.1283044-04	XYZDDS	1.0907138-04	XYZIDD	-2.6504319+01
GX	-2.6504504+01	GY	-7.3806329+00	GZ	-1.4435920+01	SWGT6	1.5000000+04	IGA	-1.0962130+02	MGA	4.9515657-01
OGA	1.7948231+02	POR	0.0000000	POR	0.0000000	POR	0.0000000	BIJ	-2.9065557-01	BIJ	9.4109753-01
BIJ	-1.6836977-01	BIJ	-4.8806322-01	BIJ	5.1076685-03	BIJ	8.7237912-01	BIJ	8.2255171-01	BIJ	3.3586153-01
BIJ	4.5891798-01	ALT	3.7963583+05	FBMAG	0.0000000	QBAR	2.6225014-02	RANGE	7.1842428+02	HA	8.0555412+01
HP	1.4868912+01	ATSMG2	2.3777836-04	ALPHA	6.3827568+00	BETA	4.3359452-02	LATD	2.7765611+01	LONG	-6.7070266+01
GAMI	4.9975811-01	GAME	5.2779915-01	VF	2.4304331+04	VGNX	-1.7407089-03	VGNY	7.9170391-03	VGNZ	2.6687622-02
FBXA	-9.8185794+00	ENG4TM	0.0000000	ENG9TM	0.0000000	ENG3TM	0.0000000	WT	3.3896477+05	XYZIDS	2.9646587+03
XYZIDS	2.1148621+04	XYZIDS	1.5738985+03	AZII	9.7362428+01	TA	1.1243995+02	TTGO	0.0000000		

ROTATIONAL DYNAMICS DATA — VEHICLE 1

TIME	4.941103+02								
TPHASE	5.0000000+00	GMT	0 8 14.110			GET	0 8 14.110		
FBX	-9.4775724+00	FBY	0.0000000	FBZ	-1.0021233+00	FMAG	9.5304055+00		
MBX	0.0000000	MBY	0.0000000	MBZ	0.0000000	MMAG	0.0000000		
OMEGX	0.0000000	OMEGY	0.0000000	OMEGZ	0.0000000	OMEGA	0.0000000		
OMEGXD	0.0000000	OMEGYD	0.0000000	OMEGZD	0.0000000	OMEGAD	0.0000000		
OGA	1.7948231+02	IGA	-1.0962130+02	MGA	4.9515657-01				
OGAD	0.0000000	IGAD	0.0000000	MGAD	0.0000000				

ROTATIONAL DYNAMICS DATA — VEHICLE 1

TIME	4.991103+02						
TPHASE	1.0000000+01	GMT	0 8 19.110			GET	0 8 19.110
FBX	-9.1527482+00	FBY	0.0000000	FBZ	-9.1177349-01	FMAG	9.1980503+00
MBX	0.0000000	MBY	0.0000000	MBZ	0.0000000	MMAG	0.0000000
OMEGX	0.0000000	OMEGY	0.0000000	OMEGZ	0.0000000	OMEGA	0.0000000
OMEGXD	0.0000000	OMEGYD	0.0000000	OMEGZD	0.0000000	OMEGAD	0.0000000
OGA	1.7948231+02	IGA	-1.0962130+02	MGA	4.9515657-01		
OGAD	0.0000000	IGAD	0.0000000	MGAD	0.0000000		

ROTATIONAL DYNAMICS DATA — VEHICLE 1

TIME	5.001103+02						
TPHASE	1.1000000+01	GMT	0 8 20.110			GET	0 8 20.110
FBX	-9.0895878+00	FBY	0.0000000	FBZ	-8.9436661-01	FMAG	9.1334822+00
MBX	0.0000000	MBY	0.0000000	MBZ	0.0000000	MMAG	0.0000000
OMEGX	0.0000000	OMEGY	0.0000000	OMEGZ	0.0000000	OMEGA	0.0000000
OMEGXD	0.0000000	OMEGYD	0.0000000	OMEGZD	0.0000000	OMEGAD	0.0000000
OGA	1.7948231+02	IGA	-1.0962130+02	MGA	4.9515657-01		
OGAD	0.0000000	IGAD	0.0000000	MGAD	0.0000000		

AERODYNAMIC DATA — VEHICLE 1

TIME	5.001103+02								
TPHASE	1.1000000+01	GMT	0 8 20.110			GET	0 8 20.110		
FBXA	-9.0895878+00	FBYA	0.0000000	FBZA	-8.9436661-01	MACH	2.0886082+01	ALPHA	5.6195086+00
MBXA	0.0000000	MBYA	0.0000000	MBZA	0.0000000	QBAR	2.3806904-02	BETA	2.8723516-02
LOD	0.0000000	CL	0.0000000	CD	1.4254765-01	LF	0.0000000	BANK	1.7933511+02

TRAJECTORY DATA — VEHICLE 1

TIME	5.001103+02								
TPHASE	1.1000000+01	GMT	0 8 20.110			GET	0 8 20.110		
XI	1.8114249+07	YI	5.3405669+06	ZI	9.8352252+06	RI	2.1292705+07	ALT	3.8199032+05
XID	-5.4673740+03	YID	2.4399553+04	ZID	-2.9693048+03	VI	2.5665087+04	LATD	2.7665268+01
XIDD	-2.6410115+01	YIDD	-7.7870114+00	ZIDD	-1.4384486+01	AI	3.1065175+01	LATC	2.7510157+01
AZIE	9.8194696+01	AZII	9.7756467+01	GAME	5.2448419-01	GAMI	4.9661399-01	LONG	-6.6266695+01
RGI	0.0000000	RGE	0.0000000	RGET	0.0000000	CRG	0.0000000	DRG	0.0000000
XDE	-5.0779338+03	YDE	2.3578642+04	ZDE	-2.9693048+03	VE	2.4301327+04		

B.1 Nominal Ascent (Continued)

CASE 1 PHASE 65 SVDS 2.3 PAGE 62

ORBITAL ELEMENT DATA — VEHICLE 1

TIME	5.001103+02										
TPHASE	1.100000+01										
A	2.1215769+07	ECC	9.3950653-03	INCL	2.8500354+01	ASC N	2.6999695+02	ARGPER	3.5133404+02		
MA	1.1220217+02	RREF	2.0925741+07	RP	2.1016465+07	RA	2.1415113+07	HP	9.0724000+04		
HA	4.8937125+05	HMAG	5.4645862+11	ENERGY	-3.3174510+08	EA	1.1269877+02	TA	1.1319449+02		
PERIOD	5.1751364+03	DESC N	8.9996953+01	ARGLAT	4.6452853+02						

VARIABLE OUTPUT

TIMEC	5.0011033+02	XYZI	1.8114249+07	XYZI	5.3405669+06	XYZI	9.8352252+06	XID	-5.4673740+03	YID	2.4899553+04
ZID	-2.9693048+03	VI	2.5665087+04	XYZDDS	1.8094103-04	XYZDDS	-8.4115345-04	XYZDDS	1.0630603-04	XYZIDD	-2.6410115+01
GX	-2.6410295+01	GY	-7.7861702+00	GZ	-1.4384592+01	SWGT6	1.5000000+04	IGA	-1.0962130+02	MGA	4.9515657-01
OGA	1.7948231+02	PQR	0.0000000	PQR	0.0000000	PQR	0.0000000	BIJ	-2.9065557-01	BIJ	9.4189753-01
BIJ	-1.6836977-01	BIJ	-4.8680322-01	BIJ	5.1076685-03	BIJ	8.7237912-01	BIJ	8.2255171-01	BIJ	3.3586153-01
BIJ	4.5891798-01	ALT	3.8199032+05	FBMAG	0.0000000	QBAR	2.3806904-02	RANGE	7.5767950+02	HA	8.0540148+01
HP	1.4931250+01	ATSMG2	8.5693699-04	ALPHA	5.6195086+00	BETA	2.8723516-02	LATD	2.7665268+01	LONG	-6.6266695+01
GAMI	4.9661399-01	GAME	5.2448419-01	VF	2.4301327+04	VGNX	-1.7407089-03	VGNY	7.9170391-03	VGNZ	2.6687622-02
FBXA	-9.0895878+00	ENG4TM	0.0000000	ENG9TM	0.0000000	ENG3TM	0.0000000	WT	3.3896477+05	XYZIDS	2.9646604+03
XYZIDS	2.1148616+04	XYZIDS	1.5738995+03	AZII	9.7756467+01	TA	1.1319449+02	TTGO	0.0000000		

B.1 Nominal Ascent (Continued)

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-----------------------------------------------------------------------------------------------
CASE  1  PHASE  70                          SVDS  2.3                                   PAGE  64
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                                   *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE     MODEL     DESCRIPTION
-------      -----     -----     -----------
IAEROF         3       AR0356    AERODYNAMICS SIMULATED FOR 3DOF
ISTAN         15       ATMSPL    1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR           1       AZTTAR    FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         3       MAENG     MAIN ENGINE MODEL IS EXECUTED
KTHROT         4       THROTL    VEHICLE IS TO BE THROTTLED
MASVAR         1       VARMAS    VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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TIME       5.001103+02                        ROTATIONAL DYNAMICS DATA                          VEHICLE 1
 TPHASE  0.0000000     GMT      0   8  20.110                          GET      0   8  20.110
 FBX    -3.5070892+00  FBY      0.0000000     FBZ    -5.3620320+03     FMAG    5.3620331+03
 MBX     0.0000000     MBY      0.0000000     MBZ     0.0000000        MMAG    0.0000000
 OMEGX   0.0000000     OMEGY    0.0000000     OMEGZ   0.0000000        OMEGA   0.0000000
 OMEGXD  0.0000000     OMEGYD   0.0000000     OMEGZD  0.0000000        OMEGAD  0.0000000
 OGA     1.7948231+02  IGA     -1.0962130+02  MGA     4.9515657-01
 OGAD    0.0000000     IGAD     0.0000000     MGAD    0.0000000

TIME       5.001103+02                          AERODYNAMIC DATA                                VEHICLE 1
 TPHASE  0.0000000     GMT      0   8  20.110                          GET      0   8  20.110
 FBXA   -3.5070892+00  FBYA     0.0000000     FBZA   -3.4507874-01     MACH    2.0886082+01  ALPHA   5.6195086+00
 MBXA    0.0000000     MBYA     0.0000000     MBZA    0.0000000        QBAR    2.3806904-02  BETA    2.8723516-02
 LOD     0.0000000     CL       0.0000000     CD      5.5000000-02     LF      0.0000000     BANK    1.7933511+02

TIME       5.001103+02                          TRAJECTORY DATA                                           VEHICLE 1
 TPHASE  0.0000000     GMT      0   8  20.110                          GET      0   8  20.110
 XI      1.8114249+07  YI       5.3405669+06  ZI      9.8352252+06     RI      2.1292705+07  ALT     3.8199032+05
 XID    -5.4673740+03  YID      2.4899553+04  ZID    -2.9693048+03     VI      2.5665087+04  LATD    2.7665268+01
 XIDD   -2.7049547+01  YIDD    -8.0477266+00  ZIDD   -1.4741241+01     AI      3.1839411+01  LATC    2.7510157+01
 AZIE    9.8194596+01  AZII     9.7756467+01  GAME    5.2448419-01     GAMI    4.9661399-01  LONG   -6.6266695+01
 RGI     0.0000000     RGE      0.0000000     RGET    0.0000000        CPG     0.0000000     DRG     0.0000000
 XDE    -5.0779338+03  YDE      2.3578642+04  ZDE    -2.9693048+03     VE      2.4301327+04

TIME       5.001103+02                        ORBITAL ELEMENT DATA                              VEHICLE 1
TPHASE     0.000000
 A       2.1215785+07  ECC      9.3950655-03  INCL    2.8500354+01     ASC N   2.6999695+02  ARGPER  3.5133404+02
 MA      1.1220217+02  RREF     2.0925741+07  RP      2.1016465+07     RA      2.1415113+07  HP      9.0724000+04
 HA      4.6937125+05  HMAG     5.4645862+11  ENERGY -3.3174510+08     EA      1.1269877+02  TA      1.1319449+02
 PERIOD  5.1751364+03  DESC N   8.9996953+01  ARGLAT  4.6452853+02
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B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  70                              SVDS  2.3                              PAGE   65
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                            VARIABLE OUTPUT
  TIMEC  5.0011033+02    XYZI  1.8114249+07    XYZI  5.3405669+06    XYZI  9.8352252+06     XID -5.4673740+03     YID  2.4899553+04
    ZID -2.9693048+03      VI  2.5665087+04  XYZDDS -6.3925207-01  XYZDDS -2.6155647-01  XYZDDS -3.5664830-01  XYZIDD -2.7049547+01
     GX -2.6410295+01      GY -7.7861702+00      GZ -1.4384592+01   SWGT6  1.5000000+04     IGA -1.0962130+02     MGA  4.9515657-01
    OGA  1.7948231+02     POR  0.0000000      PQR  0.0000000       PCR  0.0000300       BIJ -2.9065557-01     BIJ  9.4189753-01
    BIJ -1.6836977-01     BIJ -4.3880322-01     BIJ  5.1076085-03     BIJ  8.7237912-01     BIJ  8.2255171-01     BIJ  3.3586153-01
    BIJ  4.5891798-01     ALT  3.8199032+05   FBMAG  5.3616869+03    QBAR  2.3806904-02   RANGE  7.6160463+02      HA  8.0540148+01
     HP  1.4931250+01  ATSMG2  7.7733712-01   ALPHA  5.6195086+00    BETA  2.8723516-02    LATD  2.7665268+01    LONG -6.6266695+01
   GAMI  4.9661399-01    GAME  5.2448419-01      VE  2.4301327+04    VGNX -1.7407089-03    VGNY  7.9170391-03    VGNZ  2.6687622-02
   FBXA -3.5070692+00  ENG4TM  0.0000000    ENG9TM  0.0000000    ENG3TM  0.0000000        WT  2.2193500+05  XYZIDS  2.9646604+03
 XYZIDS  2.1146616+04  XYZIDS  1.5738995+03    AZII  9.7756467+01      TA  1.1319449+02    TTGO  0.0000000

TIME      5.051103+02                     ROTATIONAL DYNAMICS DATA                          VEHICLE 1
 TPHASE   5.0000000+00  GMT        0   8  25.110                  GET       0   8  25.110
 FBX     -3.3628125+00  FBY       0.0000000      FBZ     -5.3619967+03  FMAG    5.3619977+03
 MBX      0.0000000     MBY       0.0000000      MBZ      0.0000000     MMAG    0.0000000
 OMEGX    0.0000000     OMEGY     0.0000000      OMEGZ    0.0000000     OMEGA   0.0000000
 OMEGXD   0.0000000     OMEGYD    0.0000000      OMEGZD   0.0000000     OMEGAD  0.0000000
 OGA      1.7948231+02  IGA      -1.0962130+02   MGA      4.9515657-01
 OGAD     0.0000000     IGAD      0.0000000      MGAD     0.0000000

TIME      5.052601+02                     ROTATIONAL DYNAMICS DATA                          VEHICLE 1
 TPHASE   5.1497998+00  GMT        0   8  25.260                  GET       0   8  25.260
 FBX     -3.3586509+00  FBY       0.0000000      FBZ     -5.3619957+03  FMAG    5.3619967+03
 MBX      0.0000000     MBY       0.0000000      MBZ      0.0000000     MMAG    0.0000000
 OMEGX    0.0000000     OMEGY     0.0000000      OMEGZ    0.0000000     OMEGA   0.0000000
 OMEGXD   0.0000000     OMEGYD    0.0000000      OMEGZD   0.0000000     OMEGAD  0.0000000
 OGA      1.7948231+02  IGA      -1.0962130+02   MGA      4.9515657-01
 OGAD     0.0000000     IGAD      0.0000000      MGAD     0.0000000

TIME      5.052601+02                        AERODYNAMIC DATA                               VEHICLE 1
 TPHASE   5.1497398+00  GMT        0   8  25.260                  GET       0   8  25.260
 FBXA    -3.3586509+00  FBYA      0.0000000      FBZA    -3.0878270-01  MACH    2.0774539+01  ALPHA   5.2528090+00
 MBXA     0.0000000     MBYA      0.0000000      MBZA     0.0000000     QBAR    2.2785390-02  BETA    2.1869301-02
 LOD      0.0000000     CL        0.0000000      CD       5.5000000-02  LF      0.0000000     BANK    1.7933812+02

TIME      5.052601+02                         TRAJECTORY DATA                                            VEHICLE 1
 TPHASE   5.1497998+00  GMT        0   8  25.260                  GET       0   8  25.260
 XI       1.8085734+07  YI        5.4686870+06   ZI       9.8197387+06  RI      2.1293839+07  ALT     3.8307533+05
 XID     -5.6065580+03  YID       2.4957631+04   ZID     -3.0451562+03  VI      2.5663365+04  LATD    2.7616517+01
 XIDD    -2.7004479+01  YIDD     -8.2334998+00   ZIDD    -1.4716686+01  AI      3.1837286+01  LATC    2.7461597+01
 AZIE     9.8389101+01  AZII      9.7940296+01   GAME     5.1349473-01  GAMI    4.8620617-01  LONG   -6.5891101+01
 RGI      0.0000000     RGE       0.0000000      RGET     0.0000000     CRG     0.0000000     DRG     0.0000000
 XOE     -5.2077751+03  YDE       2.3538799+04   ZOE     -3.0451562+03  VE      2.4299566+04

TIME      5.052601+02                       ORBITAL ELEMENT DATA                            VEHICLE 1
 TPHASE   5.149800+00
 A        2.1215213+07  ECC       9.2597596-03   INCL     2.8500494+01  ASC N   2.6999583+02  ARGPER  3.5080661+02
 HA       1.1310701+02  RREF      2.0925741+07   RP       2.1018765+07  RA      2.1411660+07  HP      9.3024000+04
 HZ       4.8591875+05  HMAG      5.4645189+11   ENERGY  -3.3175411+08  EA      1.1359321+02  TA      1.1407851+02
 PERIOD   5.1749256+03  DESC N    8.9995836+01   ARGLAT   4.6488512+02
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B.1 Nominal Ascent (Continued)

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CASE  1  PHASE  70                                SVDS  2.3                                PAGE  66
-------------------------------------------------------------------------------------------
                                          VARIABLE OUTPUT
  TIMEC  5.0526013+02    XYZI  1.8085734+07    XYZI  5.4686870+06    XYZI  9.8197387+06     XID -5.6065580+03     YID  2.4857631+04
    ZID -3.0451562+03      VI  2.5663365+04 XYZDDS -6.3981073-01  XYZDDS -2.6176221-01  XYZDDS -3.5696012-01  XYZIDD -2.7004470+01
     GX -2.6364660+01      GY -7.9717376+00      GZ -1.4359726+01   SWGT6  1.5000000+04     IGA -1.0962130+02     MGA  4.9515657-01
    OGA  1.7948231+02     PQR  0.0000000      PQR  0.0000000       PQR  0.0000000       BIJ -2.9065557-01     BIJ  9.4189753-01
    BIJ -1.6836977-01     BIJ -4.8880322-01     BIJ  5.1076695-03     BIJ  8.7237912-01     BIJ  8.2255171-01     BIJ  3.3586153-01
    BIJ  4.5891798-01     ALT  3.2307533+05   FBMAG  5.3616869+03    QBAR  2.2765390-02   RANGE  7.8181662+02      HA  7.9971939+01
     HP  1.5309781+01  ATSMG2  7.7300883-01   ALPHA  5.2528090+00    RETA  2.1869301-02    LATD  2.7616517+01    LONG -6.5891101+01
   GAMI  4.6620617-01    GAME  5.1349473-01      VE  2.4299566+04    VGNX -1.7407089-03    VGNY  7.9170391-03    VGNZ  2.6687622-02
   FBXA -3.3586509+00  ENG4TM  0.0000000    ENG9TM  0.0000000    ENG3TM  0.0000000        WT  2.2174188+05  XYZIDS  2.9613672+03
 XYZIDS  2.1147271+04  XYZIDS  1.5720621+03    AZII  9.7940296+01      TA  1.1407851+02    TTGO  0.0000000
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  75                          SVDS  2.3                                    PAGE   68
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                   *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE     MODEL      DESCRIPTION
-------      -----     -----      -----------
IAEROF          3      ARO3S6     AERODYNAMICS SIMULATED FOR 3DOF
ISTAN          15      ATMSPL     1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR            1      AZTTAR     FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INCFLG          4      MAENG      MAIN ENGINE MODEL IS EXECUTED
KTHROT          4      THROTL     VEHICLE IS TO BE THROTTLED
MASVAR          1      VARMAS     VARIABLE MASS MODEL IS EXECUTED

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THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

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TIME      5.052601+02                           ROTATIONAL DYNAMICS DATA                     VEHICLE 1
 TPHASE  0.0000000      GMT        0   8  25.260                       GET        0   8  25.260
 FBX    -3.3586509+00   FBY      0.0000000     FBZ     -3.0878270-01   FMAG     3.3728152+00
 MBX     0.0000000      MBY      0.0000000     MBZ      0.0000000      MMAG     0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000     OMEGZ    0.0000000      OMEGA    0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000     OMEGZD   0.0000000      OMEGAD   0.0000000
 OGA     1.7946231+02   IGA     -1.0962130+02  MGA      4.9515657-01
 OGAD    0.0000000      IGAD     0.0000000     MGAD     0.0000000

TIME      5.052601+02                            AERODYNAMIC DATA                            VEHICLE 1
 TPHASE  0.0000000      GMT        0   8  25.260                       GET        0   8  25.260
 FBXA   -3.3586509+00   FBYA     0.0000000     FBZA    -3.0878270-01   MACH     2.0774539+01   ALPHA   5.2528090+00
 MBXA    0.0000000      MBYA     0.0000000     MBZA     0.0000000      QBAR     2.2785390-02   BETA    2.1869301-02
 LOD     0.0000000      CL       0.0000000     CD       5.5000000-02   LF       0.0000000      BANK    1.7933812+02

TIME      5.052601+02                            TRAJECTORY DATA                                             VEHICLE 1
 TPHASE  0.0000000      GMT        0   8  25.260                       GET        0   8  25.260
 XI      1.8065734+07   YI       5.4686870+06  ZI       9.8197387+06   RI       2.1293839+07   ALT     3.8307533+05
 XID    -5.6065580+03   YID      2.4857631+04  ZID     -3.0451562+03   VI       2.5663365+04   LATD    2.7616517+01
 XIDD   -2.6364555+01   YIDD    -7.9722116+00  ZIDD    -1.4359665+01   AI       3.1061968+01   LATC    2.7461597+01
 AZIE    9.8369101+01   AZII     9.7940295+01  GAME     5.1349473-01   GAMI     4.8620617-01   LONG   -6.5891101+01
 RGI     0.0000000      RGE      0.0000000     RGET     0.0000000      CRG      0.0000000      DRG     0.0000000
 XDE    -5.2077751+03   YDE      2.3538799+04  ZDE     -3.0451562+03   VE       2.4299566+04

TIME      5.052601+02                          ORBITAL ELEMENT DATA                          VEHICLE 1
TPHASE    0.000000
 A       2.1215213+07   ECC      9.2597596-03  INCL     2.8500494+01   ASC N    2.6999583+02   ARGPER  3.5080661+02
 MA      1.1710701+02   RREF     2.0925741+07  RP       2.1018765+07   RA       2.1411660+07   HP      9.3024000+04
 HA      4.8591075+05   HMAG     5.4645189+11  ENERGY  -3.3175411+08   EA       1.1359321+02   TA      1.1407851+02
 PERIOD  5.1749256+03   DESC N   8.9995836+01  ARGLAT   4.6488512+02
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  75                                  SVDS  2.3                                PAGE   69
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                              VARIABLE OUTPUT
  TIMEC  5.0526013+02   XYZI  1.8085734+07   XYZI  5.4686870+06   XYZI  9.8197387+06    XID -5.6065580+03    YID  2.4857631+04
    ZID -3.0451562+03     VI  2.5663365+04 XYZDDS  1.0479197-04 XYZDDS -4.7406234-04 XYZDDS  6.1490497-05 XYZIDD -2.6364555+01
     GX -2.6364660+01     GY -7.9717376+00     GZ -1.4359726+01  SWGT6  1.5000000+04    IGA -1.0962130+02    MGA  4.9515657-01
    OGA  1.7948231+02    POR  0.0000000      POR  0.0000000       POR  0.0000000       BIJ -2.9065557-01    BIJ  9.4189753-01
    BIJ -1.6836977-01    BIJ -4.8830322-01    BIJ  5.1076685-03    BIJ  8.7237912-01    BIJ  8.2255171-01    BIJ  3.3586153-01
    BIJ  4.5891798-01    ALT  3.8307533+05  FBMAG  0.0000000      QBAR  2.2785390-02  RANGE  7.8181662+02     HA  7.9971939+01
     HP  1.5309781+01 ATSMG2  4.8938485-04  ALPHA  5.2528090+00   BETA  2.1869301-02   LATD  2.7616517+01   LONG -6.5891101+01
   GAMI  4.8620617-01   GAME  5.1349473-01     VE  2.4299566+04   VGNX -1.7407089-03   VGNY  7.9170391-03   VGNZ  2.6687622-02
   FBXA -3.3586509+00 ENG4TM  0.0000000    ENG9TM  0.0000000    ENG3TM  0.0000000        WT  2.2174188+05 XYZIDS  2.9613672+03
 XYZIDS  2.1147271+04 XYZIDS  1.5720621+03   AZII  9.7940296+01     TA  1.1407851+02   TTGO  0.0000000

TIME       5.102601+02                     ROTATIONAL DYNAMICS DATA                      VEHICLE 1
 TPHASE  5.0000000+00   GMT       0   8  30.260                   GET       0   8  30.260
 FBX    -3.2240956+00   FBY      0.0000000      FBZ    -2.7673787-01   FMAG     3.2359506+00
 MBX     0.0000000      MBY      0.0000000      MBZ     0.0000000      MMAG     0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000      OMEGZ   0.0000000      OMEGA    0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000      OMEGZD  0.0000000      OMEGAD   0.0000000
 OGA     1.7948231+02   IGA     -1.0962130+02   MGA     4.9515657-01
 OGAD    0.0000000      IGAD     0.0000000      MGAD    0.0000000

TIME       5.152601+02                     ROTATIONAL DYNAMICS DATA                      VEHICLE 1
 TPHASE  1.0000000+01   GMT       0   8  35.260                   GET       0   8  35.260
 FBX    -3.0971296+00   FBY      0.0000000      FBZ    -2.4696084-01   FMAG     3.1069601+00
 MBX     0.0000000      MBY      0.0000000      MBZ     0.0000000      MMAG     0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000      OMEGZ   0.0000000      OMEGA    0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000      OMEGZD  0.0000000      OMEGAD   0.0000000
 OGA     1.7948231+02   IGA     -1.0962130+02   MGA     4.9515657-01
 OGAD    0.0000000      IGAD     0.0000000      MGAD    0.0000000

TIME       5.202601+02                     ROTATIONAL DYNAMICS DATA                      VEHICLE 1
 TPHASE  1.5000000+01   GMT       0   8  40.260                   GET       0   8  40.260
 FBX    -2.9774343+00   FBY      0.0000000      FBZ    -2.1928553-01   FMAG     2.9854985+00
 MBX     0.0000000      MBY      0.0000000      MBZ     0.0000000      MMAG     0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000      OMEGZ   0.0000000      OMEGA    0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000      OMEGZD  0.0000000      OMEGAD   0.0000000
 OGA     1.7948231+02   IGA     -1.0962130+02   MGA     4.9515657-01
 OGAD    0.0000000      IGAD     0.0000000      MGAD    0.0000000

TIME       5.251103+02                     ROTATIONAL DYNAMICS DATA                      VEHICLE 1
 TPHASE  1.9850199+01   GMT       0   8  45.110                   GET       0   8  45.110
 FBX    -2.8679841+00   FBY      0.0000000      FBZ    -1.9429906-01   FMAG     2.8745582+00
 MBX     0.0000000      MBY      0.0000000      MBZ     0.0000000      MMAG     0.0000000
 OMEGX   0.0000000      OMEGY    0.0000000      OMEGZ   0.0000000      OMEGA    0.0000000
 OMEGXD  0.0000000      OMEGYD   0.0000000      OMEGZD  0.0000000      OMEGAD   0.0000000
 OGA     1.7948231+02   IGA     -1.0962130+02   MGA     4.9515657-01
 OGAD    0.0000000      IGAD     0.0000000      MGAD    0.0000000

TIME       5.251103+02                     AERODYNAMIC DATA                              VEHICLE 1
 TPHASE  1.9850199+01   GMT       0   8  45.110                   GET       0   8  45.110
 FBXA   -2.8679841+00   FBYA     0.0000000      FBZA   -1.9429906-01   MACH     2.0396760+01  ALPHA    3.8757297+00
 MBXA    0.0000000      MBYA     0.0000000      MBZA    0.0000000      QBAR     1.9419365-02  BETA    -4.5619860-03
 LOD     0.0000000      CL       0.0000000      CD      5.5000000-02   LF       0.0000000     BANK     1.7934993+02
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  75                                 SVDS  2.3                                  PAGE   70
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

TIME      5.251103+02                        TRAJECTORY DATA                                        VEHICLE 1
 TPHASE  1.9850199+01  GMT      0  8  45.110                      GET      0  8  45.110
 XI      1.7969262+07  YI     5.9604982+06  ZI       9.7564696+06  RI    2.1298136+07  ALT     3.8717407+05
 XID    -6.1280872+03  YID    2.4692308+04  ZID     -3.3292107+03  VI    2.5658277+04  LATD    2.7418085+01
 XIDD   -2.6179523+01  YIDD  -8.6840180+00  ZIDD    -1.4258829+01  AI    3.1049860+01  LATC    2.7263946+01
 AZIE    9.9133235+01  AZII   9.8643876+01  GAME     5.0715277-01  GAMI  4.8019318-01  LONG   -6.4447125+01
 RGI     0.0000000     RGE    0.0000000     RGET     0.0000000     CRG   0.0000000     DRG     0.0000000
 XDE    -5.6934409+03  YDE    2.3381969+04  ZDE     -3.3292107+03  VE    2.4294349+04

TIME      5.251103+02                      ORBITAL ELEMENT DATA                       VEHICLE 1
TPHASE    1.985020+01
 A       2.1215392+07  ECC     9.2438614-03  INCL     2.8500962+01  ASC N  2.6999232+02  ARGPER  3.5082347+02
 MA      1.1447569+02  RREF    2.0925741+07  RP       2.1019280+07  RA     2.1411504+07  HP      9.3538750+04
 HA      4.8576300+05  HMAG    5.4645428+11  ENERGY  -3.3175131+08  EA     1.1495587+02  TA      1.1543513+02
 PERIOD  5.1749912+03  DESC N  8.9992318+01  ARGLAT   4.6625861+02

                                            VARIABLE OUTPUT
  TIMEC  5.2511033+02    XYZI  1.7969262+07    XYZI  5.9604982+06    XYZI  9.7564696+06     XID -6.1280872+03     YID  2.4692308+04
    ZID -3.3292107+03      VI  2.5658277+04  XYZDDS  9.7762563-05  XYZDDS -4.0142562-04  XYZDDS  5.7126732-05  XYZIDD -2.6179523+01
     GX -2.6179621+01      GY -8.6836166+00      GZ -1.4258886+01   SWGT6  1.5000000+04     IGA -1.0962130+02     MGA  4.9515657-01
    OGA  1.7940231+02     POR  0.0000000      POR  0.0000000       POR  0.0000000       BIJ -2.9065557-01     BIJ  9.4189753-01
    BIJ -1.6836977-01     BIJ -4.8890322-01     BIJ  5.1076685-03     BIJ  8.7237912-01     BIJ  8.2255171-01     BIJ  3.3586153-01
    BIJ  4.5621796-01     ALT  3.8717407+05   FBMAG  0.0000000      GRAR  1.9419365-02   RANGE  8.5970576+02      HA  7.9946306+01
     HP  1.5394498+01  ATSMG2  4.1708933-04   ALPHA  3.8757297+00    BETA -4.5619860-03    LATD  2.7418085+01    LONG -6.4447125+01
   GAMI  4.8019318-01    GAME  5.0715277-01      VE  2.4294349+04    VGNX -1.7407089-03    VGNY  7.9170391-03    VGNZ  2.6687622-02
   FDXA -2.8679341+00  ENG4TM  0.0000000     ENG9TM  0.0000000     ENG3TM  0.0000000        WT  2.2174188+05  XYZIDS  2.9613684+03
 XYZIDS  2.1147271+04  XYZIDS  1.5720628+03    AZII  9.8643876+01      TA  1.1543513+02    TTGO  0.0000000
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  80                          SVDS  2.3                                 PAGE   72
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                    *** PHASE INPUT SUMMARY FOR VEHICLE 1 ***
TYPE OF SIMULATION: LAUNCH
VEHICLE STATE INITIALIZATION FOR THIS PHASE:
NO VEHICLE INITIALIZATION INPUT FOR THIS PHASE
FLAG(S)      VALUE     MODEL      DESCRIPTION
-------      -----     -----      -----------
IAEROF         3       ARO3S6     AERODYNAMICS SIMULATED FOR 3DOF
ISTAN         15       ATMSPL     1963 PATRICK AFB SPLINE-FIT ATMOSPHERE ALGORITHM
ITAR           1       AZTTAR     FLYBACK AZIMUTH AND RANGE ARE COMPUTED
INGFLG         4       MAENG      MAIN ENGINE MODEL IS EXECUTED
KTHROT         4       THROTL     VEHICLE IS TO BE THROTTLED
MASVAR         1       VARMAS     VARIABLE MASS MODEL IS EXECUTED

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

THE 1963 PATRICK ATMOSPHERE IS BEING EMPLOYED FOR THIS CASE

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

TIME      5.251103+02                     ROTATIONAL DYNAMICS DATA                     VEHICLE 1
 TPHASE  0.0000000    GMT      0   8  45.110                    GET      0   8  45.110
 FBX     1.2267132+04 FBY     0.0000000     FBZ    -1.9429906-01 FMAG    1.2267132+04
 MBX     0.0000000    MBY     0.0000000     MBZ     0.0000000    MMAG    0.0000000
 OMEGX   0.0000000    OMEGY   0.0000000     OMEGZ   0.0000000    OMEGA   0.0000000
 OMEGXD  0.0000000    OMEGYD  0.0000000     OMEGZD  0.0000000    OMEGAD  0.0000000
 OGA     1.7948231+02 IGA    -1.0962130+02  MGA     4.9515657-01
 OGAD    0.0000000    IGAD    0.0000000     MGAD    0.0000000

TIME      5.251103+02                       AERODYNAMIC DATA                           VEHICLE 1
 TPHASE  0.0000000    GMT      0   8  45.110                    GET      0   8  45.110
 FBXA   -2.8679841+00 FBYA    0.0000000     FBZA   -1.9429906-01 MACH    2.0396760+01 ALPHA   3.8757297+00
 MBXA    0.0000000    MBYA    0.0000000     MBZA    0.0000000    QBAR    1.9419365-02 BETA   -4.5619860-03
 LOD     0.0000000    CL      0.0000000     CD      5.5000000-02 LF      0.0000000    BANK    1.7934993+02

TIME      5.251103+02                        TRAJECTORY DATA                                           VEHICLE 1
 TPHASE  0.0000000    GMT      0   8  45.110                    GET      0   8  45.110
 XI      1.7269262+07 YI      5.9604982+06  ZI      9.7564696+06 RI      2.1298136+07 ALT     3.8717407+05
 XID    -6.1280872+03 YID     2.4692308+04  ZID    -3.3292107+03 VI      2.5658277+04 LATD    2.7418085+01
 XIDD   -2.6696988+01 YIDD   -7.0071218+00  ZIDD   -1.4558584+01 AI      3.1205469+01 LATC    2.7263946+01
 AZIE    9.9133235+01 AZII    9.8643876+01  GAME    5.0715277-01 GAMI    4.8019318-01 LONG   -6.4447125+01
 RCI     0.0000000    RGE     0.0000000     RGET    0.0000000    CRG     0.0000000    DRG     0.0000000
 XDE    -5.6934409+03 YDE     2.3381969+04  ZDE    -3.3292107+03 VE      2.4294349+04

TIME      5.251103+02                     ORBITAL ELEMENT DATA                         VEHICLE 1
TPHASE    0.000000
 A       2.1215392+07 ECC     9.2438614-03  INCL    2.8500962+01 ASC N   2.6999232+02 ARGPER  3.5082347+02
 MA      1.1447569+02 RPEF    2.0725741+07  RP      2.1019280+07 RA      2.1411504+07 HP      9.3538750+04
 HA      4.8576300+05 HMAG    5.4645428+11  ENERGY -3.3175131+08 EA      1.1495587+02 TA      1.1543513+02
 PERIOD  5.1749912+03 DESC N  8.9992318+01  ARGLAT  4.6625851+02
```

B.1 Nominal Ascent (Continued)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  80                            SVDS  2.3                                 PAGE   73
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                          VARIABLE OUTPUT
  TIMEC  5.2511033+02    XYZI  1.7969262+07    XYZI  5.9604992+06    XYZI  9.7564696+06     XID -6.1280872+03     YID  2.4692308+04
    ZID -3.3292107+03      VI  2.5656277+04 XYZDDS -5.1736750-01 XYZDDS  1.6764949+00 XYZDDS -2.9969803-01 XYZIDD -2.6696988+01
     GX -2.6179621+01      GY -8.6836166+00      GZ -1.4258836+01   SWGT6  1.5000000+04     IGA -1.0962130+02     MGA  4.9515657-01
    OGA  1.7946231+02     PQR  0.0000000      PQR  0.0000000       PQR  0.0000000       BIJ -2.9065557-01     BIJ  9.4189753-01
    BIJ -1.6836977-01     BIJ -4.8896322-01     BIJ  5.1076685-03     BIJ  8.7237912-01     BIJ  8.2255171-01     BIJ  3.3586153-01
    BIJ  4.5891798-01     ALT  3.8717407+05   FBMAG  1.2270000+04    QBAR  1.9419365-02   RANGE  8.5970576+02      HA  7.9946306+01
     HP  1.5394498+01  ATSMG2  1.7799222+00   ALPHA  3.8757297+00    BETA -4.5619860-03    LATD  2.7418085+01    LONG -6.4447125+01
   GAMI  4.8019318-01    GAME  5.0715277-01      VE  2.4294349+04    VGNX -7.3561103+01    VGNY -1.2542571-01    VGNZ  1.9591858+02
   FBXA -2.8679841+00  ENG4TM  0.0000000     ENG9TM  2.7000000+02  ENG3TM  0.0000000        WT  2.2174188+05 XYZIDS  2.9613684+03
 XYZIDS  2.1147271+04  XYZIDS  1.5720628+03    AZII  9.8643876+01      TA  1.1543513+02    TTGO  1.3763812+02

TIME        6.397239+02                     ROTATIONAL DYNAMICS DATA                        VEHICLE 1
 TPHASE    1.1461359+02   GMT       0  10  39.724                   GET      0  10  39.724
 FBX       1.2268819+04   FBY       0.0000000    FBZ     -4.3314352-04  FMAG     1.2268819+04
 MBX       0.0000000      MBY       0.0000000    MBZ      0.0000000     MMAG     0.0000000
 OMEGX     0.0000000      OMEGY     0.0000000    OMEGZ    0.0000000     OMEGA    0.0000000
 OMEGXD    0.0000000      OMEGYD    0.0000000    OMEGZD   0.0000000     OMEGAD   0.0000000
 OGA       1.7946594+02   IGA      -1.1368329+02 MGA     -3.0902552-02
 OGAD      0.0000000      IGAD      0.0000000    MGAD     0.0000000

TIME        6.397239+02                     AERODYNAMIC DATA                                VEHICLE 1
 TPHASE    1.1461359+02   GMT       0  10  39.724                   GFT      0  10  39.724
 FBXA     -1.1806757+00   FBYA      0.0000000    FBZA    -4.3314352-04  MACH     1.7621969+01  ALPHA    2.1019571-02
 MBXA      0.0000000      MBYA      0.0000000    MBZA     0.0000000     QBAR     7.9761731-03  BETA    -7.1345482-01
 LOD       0.0000000      CL        0.0000000    CD       5.5000000-02  LF       0.0000000     BANK     1.7937202+02

TIME        6.397239+02                     TRAJECTORY DATA                                              VEHICLE 1
 TPHASE    1.1461359+02   GMT       0  10  39.724                   GET      0  10  39.724
 XI        1.7094352+07   YI        8.7358785+06 ZI       9.2809197+06  RI       2.1322943+07  ALT      4.1054585+05
 XID      -9.1173380+03   YID       2.3661098+04 ZID     -4.9572426+03  VI       2.5836943+04  LATD     2.5949719+01
 XIDD     -2.5473329+01   YIDD     -1.0995157+01 ZIDD    -1.3872734+01  AI       3.1019941+01  LATC     2.5801527+01
 AZIE      1.0326682+02   AZII      1.0255437+02 GAME     5.3118267-01  GAMI     5.0313016-01  LONG    -5.6208145+01
 RGI       0.0000000      RGE       0.0000000    RGET     0.0000000     CRG      0.0000000     DRG      0.0000000
 XDE      -8.4803077+03   YDE       2.2414558+04 ZDE     -4.9572426+03  VE       2.4472479+04

TIME        6.397239+02                     ORBITAL ELEMENT DATA                            VEHICLE 1
 TPHASE     1.146136+02
 A         2.1564397+07   ECC       1.4229155-02 INCL     2.8504335+01  ASC N    2.6997307+02  ARGPER   7.5599663+01
 MA        3.7600567+01   RPEF      2.0925741+07 RP       2.1257553+07  RA       2.1871240+07  HP       3.3181200+05
 HA        9.4549825+05   HMAG      5.5089844+11 ENERGY  -3.2638215+08  EA       3.8103659+01  TA       3.8609606+01
 PERIOD    5.3032120+03   DESC N    8.9973071+01 ARGLAT   1.1420927+02
```

B.1 Nominal Ascent (Concluded)

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- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CASE  1  PHASE  80                                    SVDS  2.3                                             PAGE  81
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                                               VARIABLE OUTPUT
   TIMEC  6.3972392+02    XYZI  1.7094352+07    XYZI  8.7358785+06    XYZI  9.2809197+06     XID -9.1173380+03     YID  2.3661098+04
     ZID -4.9572426+03      VI  2.5836943+04 XYZDDS -6.5110809-01 XYZDDS  1.6896393+00  XYZDDS -3.5398626-01  XYZIDD -2.5473329+01
      GX -2.4822221+01      GY -1.2684796+01      GZ -1.3518748+01  SWGT6  1.0608699+04     IGA -1.1368329+02     MGA -3.0902552-02
     OGA  1.7946594+02     PQR  0.0000000       PQR  0.0000000       PQR  0.0000000       BIJ -3.5289871-01     BIJ  9.1577969-01
     BIJ -1.9185953-01     BIJ -4.8610429-01     BIJ -4.2362354-03     BIJ  8.7389054-01     BIJ  7.9947844-01     BIJ  4.0165858-01
     BIJ  4.4665939-01     ALT  4.1054585+05   FBMAG  1.2270000+04    QBAR  7.9761731-03   RANGE  1.3083555+03      HA  1.5560900+02
      HP  5.4609231+01  ATSMG2  1.8450282+00   ALPHA  2.1019571-02    BETA -7.1345482-01    LATD  2.5949719+01    LONG -5.6208145+01
    GAMI  5.0313016-01    GAME  5.3118267-01      VE  2.4472479+04    VGNX  1.9547343-04    VGNY  2.2686683-05    VGNZ -2.2795796-04
    FBXA -1.1806757+00  ENG4TM  0.0000000    ENG9TM  2.7000000+02  ENG3TM  0.0000000        WT  2.1394665+05  XYZIDS  2.8995833+03
  XYZIDS  2.1342498+04  XYZIDS  1.5384530+03    AZII  1.0255437+02      TA  3.8609606+01    TTGO  0.0000000

TIME        8.397239+02                        ROTATIONAL DYNAMICS DATA                          VEHICLE 1
 TPHASE   2.0000000+02   GMT        0  13   59.724                  GET        0  13   59.724
 FBX     -3.2284789-01   FBY        0.0000000     FBZ      -3.7703900-03  FMAG     3.2286990-01
 MBX      0.0000000      MBY        0.0000000     MBZ       0.0000000     MMAG     0.0000000
 OMEGX    0.0000000      OMEGY      0.0000000     OMEGZ     0.0000000     OMEGA    0.0000000
 OMEGXD   0.0000000      OMEGYD     0.0000000     OMEGZD    0.0000000     OMEGAD   0.0000000
 OGA     -1.7990822+02   IGA       -1.2803965+02  MGA      -3.8818957-02
 OGAD     0.0000000      IGAD       0.0000000     MGAD      0.0000000

TIME        8.397239+02                        AERODYNAMIC DATA                                  VEHICLE 1
 TPHASE   2.0000000+02   GMT        0  13   59.724                  GET        0  13   59.724
 FBXA    -3.2284789-01   FBYA       0.0000000     FBZA     -3.7703900-03  MACH     1.3759942+01   ALPHA    6.6910029-01
 MBXA     0.0000000      MBYA       0.0000000     MBZA      0.0000000     QBAR     2.1811799-03   BETA    -1.0771156+00
 LOD      0.0000000      CL         0.0000000     CD        5.5000000-02  LF       0.0000000      BANK    -1.7998742+02

TIME        8.397239+02                        TRAJECTORY DATA                                                      VEHICLE 1
 TPHASE   2.0000000+02   GMT        0  13   59.724                  GET        0  13   59.724
 XI       1.4795263+07   YI         1.3171037+07  ZI        8.0304564+06  RI       2.1374383+07   ALT      4.5858677+05
 XID     -1.3756630+04   YID        2.0478474+04  ZID      -7.4836063+03  VI       2.5780169+04   LATD     2.2199295+01
 XIDD    -2.1337209+01   YIDD      -1.8994542+01  ZIDD     -1.1617378+01  AI       3.0838816+01   LATC     2.2067875+01
 AZIE     1.0960320+02   AZII       1.0852601+02  GAME      6.6898298-01  GAMI     6.3355479-01   LONG    -4.2436444+01
 RGI      0.0000000      RGE        0.0000000     RGET      0.0000000     CRG      0.0000000      DRG      0.0000000
 XDE     -1.2796183+04   YDE        1.9399587+04  ZDE      -7.4836063+03  VE       2.4414967+04

TIME        8.397239+02                        ORBITAL ELEMENT DATA                              VEHICLE 1
 TPHASE     2.000000+02
 A        2.1572558+07   ECC        1.4375193-02  INCL      2.8512219+01  ASC N    2.6994556+02   ARGPER  7.7171876+01
 MA       4.9645636+01   RREF       2.0925741+07  RP        2.1262448+07  RA       2.1882667+07   HP      3.3670675+05
 HA       9.5692550+05   HMAG       5.5100152+11  ENERGY   -3.2625868+08  EA       5.0279151+01   TA      5.0915616+01
 PERIOD   5.3062227+03   DESC N     8.9945561+01  ARGLAT    1.2808749+02

                                               VARIABLE OUTPUT
   TIMEC  8.3972392+02    XYZI  1.4795263+07    XYZI  1.3171037+07    XYZI  8.0304564+06     XID -1.3756630+04     YID  2.0478474+04
     ZID -7.4836063+03      VI  2.5780169+04 XYZDDS  2.6109162-05 XYZDDS -3.8916799-05  XYZDDS  1.4203409-05  XYZIDD -2.1337209+01
      GX -2.1337235+01      GY -1.8994503+01      GZ -1.1617392+01  SWGT6  1.0608699+04     IGA -1.2803965+02     MGA -3.8818957-02
     OGA -1.7990822+02     PQR  0.0000000       PQR  0.0000000       PQR  0.0000000       BIJ -5.4129983-01     BIJ  7.8758439-01
     BIJ -2.9445769-01     BIJ -4.7734598-01     BIJ  4.5351664-04     BIJ  8.7871533-01     BIJ  6.9219600-01     BIJ  6.1620665-01
     BIJ  3.7570475-01     ALT  4.5858677+05   FBMAG  0.0000000       QBAR  2.1811799-03   RANGE  2.0988632+03      HA  1.5748968+02
      HP  5.5414803+01  ATSMG2  4.8968789-05   ALPHA  6.6910029-01    BETA -1.0771156+00    LATD  2.2199295+01    LONG -4.2436444+01
    GAMI  6.3355479-01    GAME  6.6898298-01      VE  2.4414967+04    VGNX  1.9547343-04    VGNY  2.2686683-05    VGNZ -2.2795796-04
    FBXA -3.2284789-01  ENG4TM  0.0000000    ENG9TM  0.0000000    ENG3TM  0.0000000        WT  2.1213577+05  XYZIDS  2.8984504+03
  XYZIDS  2.1345028+04  XYZIDS  1.5378369+03    AZII  1.0852601+02      TA  5.0915616+01    TTGO  0.0000000
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B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer

END ASCENT

GET 0 DAYS, 0 HRS, 13 MINS, 59.724 SECS
GMT 1 JAN 1981, 15 HRS, 4 MINS, 2.124 SECS GETHRS 2.3325660-01 GETSFC 8.3972375+02

ORB	ACTIVE STATE	GMT	2.1213577+05	WPRCS	7.2497000+03	WPMAN	1.0606699+04	TRMAN	3.2258333-02	CDAREA	6.2230000+03
X	8.3009755+02	Y	-3.1520035+03	Z	1.3210431+03	DX	2.4487919+04	DY	2.9424165+03	DZ	-7.4830035+03
R	3.5177707+03	DEC	2.2067876+01	RA	-7.5248533+01	V	2.5780168+04	BETA	8.9360430+01	AZ	1.0852601+02
ALT	7.5473091+01	LAT	2.2194281+01	LON	-4.2436455+01	VE	2.4414966+04	GAMDE	6.2490769-01	AZDE	1.0960460+02
HP	5.5416922+01	HAPO	1.5749217+02	INC	2.8512219+01	RAN	1.5302092+02	APF	7.7170752+01	MA	4.9046732+01
HPM	5.7531433+01	HAPOM	1.5966507+02	AM	3.5525292+03	ECC	1.4374784-02	PERM	1.4752852+00	ALTFO	7.3039813+01
CTRLIM	7.8239878+01	LIMSUN	5.6644323+01	DTRISE	-3.6230407-01	DTSET	5.3037263-01	PER	1.4739502+00	TA	5.0916707+01

B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Continued)

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                                   BEGIN ORB CIRC  BURN

                GET        0 DAYS,  0 HRS, 44 MINS, 26.827 SECS            GETHRS  7.4078535-01  GETSEC  2.6668272+03
                GMT   1 JAN 1981, 15 HRS, 34 MINS, 29.227 SECS

 ORB ACTIVE STATE     GMT  2.1213577+05   WPRCS  7.2487000+03   WPMAN  1.0608699+04   TRMAN  3.2258333-02  CDAREA  6.2230000+03
       X 2.3923799+03   Y  2.1358268+03       Z -1.6240605+03      DX -1.7997990+04      DY  1.7237138+04      DZ -3.6840620+03
       H 3.5946310+03 DEC -2.6857727+01      RA  4.1757279+01       V  2.5221667+04    BETA  8.9958632+01      AZ  9.9916750+01
     ALT 1.5326214+02 LAT -2.7006473+01     LON  6.6935583+01      VE  2.3823188+04   GAMDE  7.0922730-02    AZDE  1.0050729+02
      HP 5.9218807+01 HAPO 1.5097164+02     INC  2.8502484+01     RAN  1.5291676+02     APF  7.4374990+01      MA  1.7675691+02
     HPM 6.0552094+01 HAPOM 1.5233777+02     AM  3.5503759+03     ECC  1.2926203-02    PERM  1.4739441+00   ALTFQ  1.5090009+02
  CTRLIM 7.3340032+01 LIMSUN 3.3817196+00 DTRISE -8.7142316-01  DTSFT -1.4529946+00     PER  1.4731038+00      TA  1.7683938+02
  THRMAG 1.2000000+04 ISP  3.1320000+02    WDOT -1.3793104+05     TUX -7.4955004-01     TUY  6.4934460-01     TUZ -1.2855469-01
  TUXLVH 9.9848901-01 TUYLVH -6.6389330-05 TUZLVH 5.4951186-02    PCH -3.1500579+00     YAW -3.8095847-03

 ORB OMS     BURN   DVIDEL  1.7442045+02  DWPRCS  0.0000000     DWPMAN -3.6402461+03   DTHRS  2.6391797-02   DTSEC  9.5010468+01

                                   END ORB CIRC  BURN

                GET        0 DAYS,  0 HRS, 46 MINS,  1.838 SECS            GETHRS  7.6717715-01  GETSEC  2.7618377+03
                GMT   1 JAN 1981, 15 HRS, 36 MINS,  4.238 SECS

 ORB ACTIVE STATE     GMT  2.0844552+05   WPRCS  7.2487000+03   WPMAN  6.9684529+03   TRMAN  5.8650129-02  CDAREA  6.2230000+03
       X 2.0959351+03   Y  2.3420862+03       Z -1.6749254+03      DX -1.9480366+04      DY  1.5583305+04      DZ -2.6152653+03
       H 3.5948944+03 DEC -2.7764634+01      RA  4.8782427+01       V  2.5395053+04    BETA  9.0001044+01      AZ  9.6684237+01
     ALT 1.5347583+02 LAT -2.7921763+01     LON  7.3563771+01      VE  2.3495825+04   GAMDE  1.7634029-02    AZDE  9.7075919+01
      HP 1.5096265+02 HAPO 1.5621316+02     INC  2.8500427+01     RAN  1.5290135+02     APF -1.0105239+02      MA -1.4303815+00
     HPM 1.5220935+02 HAPOM 1.5740158+02     AM  3.5987604+03     ECC  7.2972928-04    PERM  1.5041807+00   ALTFQ  1.5090350+02
  CTRLIM 7.3330054+01 LIMSUN -1.0595846+00 DTRISE 5.5054394-01  DTSFT -6.3216537-03     PER  1.5033987+00      TA  3.5650905+02
  THRMAG 1.2000000+04 ISP  3.1320000+02    WDOT -1.3793104+05     TUX -7.4955004-01     TUY  6.4934460-01     TUZ -1.2855469-01
  TUXLVH 9.9848220-01 TUYLVH 6.6898763-05 TUZLVH -5.5075112-02    PCH  3.1571690+00     YAW  3.8384434-03
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B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Continued)


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                                     BEGIN ORB/IUS SEP BURN

                GET      0 DAYS,  2 HRS, 45 MINS, 57.228 SECS         GETHRS  2.7658966+00  GETSFC  9.9572275+03
                GMT   1 JAN 1981, 17 HRS, 35 MINS, 59.627 SECS

ORB ACTIVE STATE      GMT  1.7380252+05  WPRCS  7.2487000+03  WPMAN  6.9684529+03  TRMAN  5.8650129-02  COAREA  6.2230000+03
     X -3.4764680+03    Y  7.5906152+02      Z  5.1388052+02     DX -3.1745116+03     DY -2.2384451+04      DZ  1.1575604+04
     R  3.5952854+03  DEC  8.2175311+00     RA  1.6768318+02      V  2.5399522+04   BETA  9.0004148+01      AZ  6.2581960+01
   ALT  1.5158823+02  LAT  8.2698240+00    LON  1.6240166+02     VE  2.4010970+04  GAMDE  2.1085436-02    AZDE  6.0849280+01
    HP  1.5134052+02 HAPO  1.5993412+02    INC  2.8531299+01    RAN  1.5227865+02    APF  2.0895333+01      MA -3.4740780+00
   HPM  1.5471426+02 HAPOM 1.6328766+02     AM  3.6029319+03    ECC  1.1897942-03   PERM  1.5067930+00   ALTFQ  1.5135446+02
CTRLIM  7.3315851+01 LIMSUN -9.0568800+00 DTRISE 5.5514481-02  DTSET -5.0167927-01    PFR  1.5046854+00      TA  3.5651705+02
THRMAG  2.6100000+03  ISP  2.8900000+02   WDOT -3.2512111+04    TUX -1.2498312-01    TUY -8.8129412-01     TUZ  4.5574099-01
TUXLVH  9.9997996-01 TUYLVH 0.0000000   TUZLVH  7.2382390-05    PCH -4.1472057-03    YAW  0.0000000

IUS PASIVE STATE      GMT  3.4693000+04  WPRCS  2.3400000+02  WPMAN  2.7627000+04  TRMAN  0.0000000     COAREA  0.0000000
     X -3.4764601+03    Y  7.5905978+02      Z  5.1387935+02     DX -3.1745116+03     DY -2.2384451+04      DZ  1.1575604+04
     R  3.5952772+03  DEC  8.2175312+00     RA .1.6768318+02      V  2.5399522+04   BETA  9.0004148+01      AZ  6.2581960+01
   ALT  1.5157997+02  LAT  8.2698241+00    LON  1.6240166+02     VE  2.4010973+04  GAMDE  2.1085436-02    AZDE  6.0849284+01
    HP  1.5133820+02 HAPO  1.5990938+02    INC  2.8531299+01    RAN  1.5227865+02    APF  2.0902086+01      MA -3.4814307+00
   HPM  1.5472040+02 HAPOM 1.6324857+02     AM  3.6029154+03    ECC  1.1835156-03   PERM  1.5067827+00   ALTFQ  1.5134625+02
CTRLIM  7.3316288+01 LIMSUN -9.0573168+00 DTRISE 5.5317014-02  DTSET -5.0168315-01    PER  1.5046751+00      TA  3.5651030+02
  DELX  7.9543783-03 DELY -1.7320017-03   DELZ -1.1739123-03  DELDX  0.0000000      DELDY  0.0000000     DELDZ  0.0000000
 RANGE  8.2249640-03  ELV -8.9965354+01    DAZ -1.3242577+02  RRATE  0.0000000     ELVDOT -1.6179302+02  DAZDOT  2.9275398+05


ORB RCS    BURN   DVIDEL  3.9997900+00  DWPRCS -7.4750000+01  DWPMAN  0.0000000     DTHRS  2.2991598-03   DTSFC  8.2769752+00


                                      END ORB/IUS SEP BURN

                GET      0 DAYS,  2 HRS, 46 MINS,  5.505 SECS         GETHRS  2.7681957+00  GETSFC  9.9655045+03
                GMT   1 JAN 1981, 17 HRS, 36 MINS,  7.904 SECS

ORB ACTIVE STATE      GMT  1.7372777+05  WPRCS  7.1739500+03  WPMAN  6.9684529+03  TRMAN  5.8650129-02  COAREA  6.2230000+03
     X -3.4606315+03    Y  7.2853178+02      Z  5.2962621+02     DX -2.9384570+03     DY -2.2438556+04      DZ  1.1541840+04
     R  3.5952827+03  DEC  8.4711516+00     RA  1.6817808+02      V  2.5403491+04   BETA  9.0004175+01      AZ  6.2653989+01
   ALT  1.5160024+02  LAT  8.5250114+00    LON  1.6286197+02     VE  2.4014868+04  GAMDE  2.1755914-02    AZDE  6.0926916+01
    HP  1.5134539+02 HAPO  1.6218059+02    INC  2.8531101+01    RAN  1.5227852+02    APF  2.0743698+01      MA -2.7714316+00
   HPM  1.5468814+02 HAPOM 1.6553613+02     AM  3.6040431+03    ECC  1.5049839-03   PERM  1.5074901+00   ALTFQ  1.5135175+02
CTRLIM  7.3315995+01 LIMSUN -8.6947079+00 DTRISE 5.3001851-02  DTSET -5.0356412-01    PER  1.5053894+00      TA  3.5722016+02
THRMAG  2.6100000+03  ISP  2.8900000+02   WDOT -3.2512111+04    TUX -1.1567138-01    TUY -8.8328628-01     TUZ  4.5434069-01
TUXLVH  9.9999998-01 TUYLVH 0.0000000   TUZLVH  7.2860159-05    PCH -4.1745797-03    YAW  0.0000000

IUS PASIVE STATE      GMT  3.4693000+04  WPRCS  2.3400000+02  WPMAN  2.7627000+04  TRMAN  0.0000000     COAREA  0.0000000
     X -3.4806231+03    Y  7.2853228+02      Z  5.2962383+02     DX -2.9379743+03     DY -2.2435028+04      DZ  1.1540020+04
     R  3.5952743+03  DEC  8.4711332+00     RA  1.6817804+02      V  2.5399492+04   BETA  9.0004262+01      AZ  6.2653965+01
   ALT  1.5159142+02  LAT  8.5249929+00    LON  1.6286193+02     VE  2.4010874+04  GAMDE  2.1064561-02    AZDE  6.0926627+01
    HP  1.5133502+02 HAPO  1.5988393+02    INC  2.8531100+01    RAN  1.5227852+02    APF  2.1558835+01      MA -3.5864361+00
   HPM  1.5471521+02 HAPOM 1.6319778+02     AM  3.6028874+03    ECC  1.1772035-03   PERM  1.5067651+00   ALTFQ  1.5134358+02
CTRLIM  7.3316440+01 LIMSUN -8.6951790+00 DTRISE 5.3021699-02  DTSET -5.0348472-01    PFR  1.5046661+00      TA  3.5604495+02
  DELX  8.3649268-03 DELY  5.0035605-04   DELZ -2.3734838-03  DELDX  4.8271089-01      DELDY  3.5283888+00   DELDZ -1.8204948+00
 RANGE  8.7095224-03  ELV -7.3397561+01    DAZ  1.7965151+02  RRATE  1.1624296+00     ELVDOT  1.4676003+04  DAZDOT  3.2260981+02
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B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Continued)

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BEGIN ORB CIRC BURN

GET 0 DAYS, 3 HRS, 31 MINS, 5.505 SECS GETHRS 3.5181957+00 GETSEC 1.2665505+04
GMT 1 JAN 1981, 18 HRS, 21 MINS, 7.904 SECS

ORB ACTIVE STATE		GMT	1.7372777+05	WPRCS	7.1739500+03	WPMAN	6.9684529+03	TRMAN	5.8650129-02	CDAREA	6.2230000+03
X	3.4795947+03	Y	-7.4377753+02	Z	-5.2468967+02	DX	3.0330042+03	DY	2.2412116+04	DZ	-1.1535608+04
R	3.5974095+03	DEC	-8.4671285+00	RA	-1.2065630+01	V	2.5388428+04	RETA	9.0003583+01	AZ	1.1734717+02
ALT	1.5372688+02	LAT	-8.5209314+00	LON	-2.8662542+01	VE	2.3998998+04	GAMDE	2.2357345-02	AZDE	1.1907650+02
HP	1.5347080+02	HAPO	1.6001961+02	INC	2.8531104+01	RAN	1.5204268+02	APF	-1.5809842+02	MA	-3.4592546+00
HPM	1.5682593+02	HAPOM	1.6335129+02	AM	3.6040195+03	ECC	9.0529767-04	PERM	1.5074753+00	ALTEU	1.5347856+02
CTRLIM	7.3203341+01	LIMSUN	4.2430025+01	DTRISE	-7.0065784-01	DTSET	2.4781105-01	PER	1.5053782+00	TA	3.5005303+02
THRMAG	2.6100000+03	ISP	2.8900000+02	WDOT	-3.2512111+04	TUX	1.1940404-01	TUY	8.8276893-01	TUZ	-4.5436478-01
TUXLVH	9.9999999-01	TUYLVH	-3.7252903-09	TUZLVH	6.2527135-05	PCH	-3.5825410-03	YAW	-2.1344342-07		
IUS PASIVE STATE		GMT	3.4693000+04	WPRCS	2.3400000+02	WPMAN	2.7627000+04	TRMAN	0.0000000	CDAREA	0.0000000
X	3.4780333+03	Y	-7.3853451+02	Z	-5.3181366+02	DX	2.9975765+03	DY	2.2430646+04	DZ	-1.1535449+04
R	3.5951319+03	DEC	-8.5067570+00	RA	-1.1988269+01	V	2.5400510+04	RETA	9.0003405+01	AZ	1.1733570+02
ALT	1.5145162+02	LAT	-8.5608388+00	LON	-2.8585161+01	VE	2.4011935+04	GAMDE	2.2669773-02	AZDE	1.1906215+02
HP	1.5119590+02	HAPO	1.6003054+02	INC	2.8531071+01	RAN	1.5204253+02	APF	-1.5918013+02	MA	-2.7716014+00
HPM	1.5456061+02	HAPOM	1.6335672+02	AM	3.6028896+03	ECC	1.2207031-03	PERM	1.5067665+00	ALTEU	1.5120102+02
CTRLIM	7.3324012+01	LIMSUN	4.2252647+01	DTRISE	-7.0064795-01	DTSET	2.4066750-01	PER	1.5046684+00	TA	3.5722158+02
DELX	-1.5614701+00	DELY	5.2430258+00	DELZ	-2.1239858+00	DELDX	-3.5427628+01	DELDY	1.8529585+01	DELDZ	1.5850726-01
RANGE	5.8684600+00	ELV	-2.2879319+01	DAZ	3.9102616-02	RRATE	2.5923940+01	ELVDOT	6.3508020+01	DAZDOT	-2.6975383-01

ORB RCS BURN DVIDEL 3.9999285+00 DWPRCS -7.4718750+01 DWPMAN 0.0000000 DTHRS 2.2981763-03 DTSEC 8.2734346+00

END ORB CIRC BURN

GET 0 DAYS, 3 HRS, 31 MINS, 13.778 SECS GETHRS 3.5204939+00 GETSEC 1.2673778+04
GMT 1 JAN 1981, 18 HRS, 21 MINS, 16.178 SECS

ORB ACTIVE STATE		GMT	1.7365305+05	WPRCS	7.0992312+03	WPMAN	6.9684529+03	TRMAN	5.8650129-02	CDAREA	6.2230000+03
X	3.4635640+03	Y	-7.1322403+02	Z	-5.4537344+02	DX	2.7472448+03	DY	2.2465078+04	DZ	-1.1500844+04
R	3.5974071+03	DEC	-8.7197653+00	RA	-1.1570816+01	V	2.5392394+04	RETA	9.0003762+01	AZ	1.1727302+02
ALT	1.5373960+02	LAT	-8.7751238+00	LON	-2.8202246+01	VE	2.4002892+04	GAMDE	2.2855842-02	AZDE	1.1894659+02
HP	1.5346988+02	HAPO	1.6220603+02	INC	2.8530900+01	RAN	1.5204254+02	APF	-1.5840814+02	MA	-3.0784234+00
HPM	1.5682065+02	HAPOM	1.6557806+02	AM	3.6051303+03	ECC	1.2145843-03	PERM	1.5081723+00	ALTEU	1.5347623+02
CTRLIM	7.3203465+01	LIMSUN	4.2066731+01	DTRISE	-7.0394826-01	DTSET	2.4565381-01	PER	1.5060824+00	TA	3.5091404+02
THRMAG	2.6100000+03	ISP	2.8900000+02	WDOT	-3.2512111+04	TUX	1.1016073-01	TUY	8.8471679-01	TUZ	-4.5292473-01
TUXLVH	9.9999999-01	TUYLVH	-3.7252903-09	TUZLVH	6.5655448-05	PCH	-3.7617801-03	YAW	-2.1344342-07		
IUS PASIVE STATE		GMT	3.4693000+04	WPRCS	2.3400000+02	WPMAN	2.7627000+04	TRMAN	0.0000000	CDAREA	0.0000000
X	3.4819538+03	Y	-7.0795816+02	Z	-5.4749593+02	DX	2.7610154+03	DY	2.2479869+04	DZ	-1.1496655+04
R	3.5951298+03	DEC	-8.7595557+00	RA	-1.1492837+01	V	2.5400473+04	RETA	9.0003495+01	AZ	1.1726112+02
ALT	1.5146470+02	LAT	-8.8151940+00	LON	-2.8124316+01	VE	2.4011828+04	GAMDE	2.3262965-02	AZDE	1.1858267+02
HP	1.5119338+02	HAPO	1.6000376+02	INC	2.8530866+01	RAN	1.5204239+02	APF	-1.5854740+02	MA	-2.5526149+00
HPM	1.5453195+02	HAPOM	1.6332800+02	AM	3.6028609+03	ECC	1.2207031-03	PERM	1.5067485+00	ALTEU	1.5119491+02
CTRLIM	7.3324124+01	LIMSUN	4.1888762+01	DTRISE	-7.0294875-01	DTSET	2.4435088-01	PER	1.5046542+00	TA	3.5714022+02
DELX	-1.6101714+00	DELY	5.2658690+00	DELZ	-2.1224847+00	DELDX	-3.6224410+01	DELDY	1.4730781+01	DELDZ	2.1883529+00
RANGE	5.9014379+00	ELV	-2.2742705+01	DAZ	3.8523307-02	RRATE	2.2242236+01	ELVDOT	5.4140881+01	DAZDOT	-2.5013705-01

B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Continued)


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                                          BEGIN IUS 1ST STAGE BURN

                 GET      0 DAYS,  5 HRS, 45 MINS,  6.288 SECS                  GETHRS  5.7517465+00  GETSEC  2.0706287+04
                 GMT   1 JAN 1981, 20 HRS, 35 MINS,  8.087 SECS

IUS ACTIVE STATE     GMT  3.4693000+04   WPRCS  2.3400000+02   WPMAN  2.7627000+04   TBMAN  0.0000000     CDAREA  0.0000000
     X -3.4313611+03       Y  9.8524962+02       Z  4.2480614+02      DX -4.8564182+03      DY -2.1986392+04      DZ  1.1755244+04
     R  3.5952069+03     DEC  6.7058604+00      RA  1.6397883+02       V  2.5400236+04    BETA  9.0003355+01      AZ  6.2220345+01
   ALT  1.5133479+02     LAT  6.4292425+00     LON  1.1376693+02      VE  2.4012067+04   GAMDE  1.7837066-02    AZDE  6.0460948+01
    HP  1.5127742+02    HAPO  1.6010059+02     INC  2.8532225+01     RAN  1.5133654+02     APF  1.7061521+01      MA -2.7320243+00
   HPM  1.5469608+02   HAPOM  1.6353638+02      AM  3.6030471+03     ECC  1.2267915-03    PERM  1.5068653+00   ALTEQ  1.5127603+02
CTRLIM  7.3320021+01  LIMSUN -1.2055593+01  DTRISE  7.3974431-02   DTSET -4.8440862-01     PER  1.5047139+00      TA  3.5726073+02
THRMAG  4.2600000+04     ISP  2.9028000+02    WDOT -5.2831748+05     TUX -3.3203281-01     TUY -9.3886086-01     TUZ  9.1074148-02
TUXLVM  9.1631257-01  TUYLVM  3.8955311-01  TUZLVM -7.0358855-02     PCM  4.0345990+00     YAW  2.2986917+01

ORB PASIVE STATE     GMT  1.7365305+05   WPRCS  7.0992312+03   WPMAN  6.9684529+03   TBMAN  5.8650129-02  CDAREA  6.2230000+03
     X -3.4262856+03       Y  1.0176755+03       Z  4.0801106+02      DX -5.1024142+03      DY -2.1907155+04      DZ  1.1781774+04
     R  3.5974343+03     DEC  6.5123425+00      RA  1.6345753+02       V  2.5392287+04    BETA  9.0003102+01      AZ  6.2159629+01
   ALT  1.5365437+02     LAT  6.5539753+00     LON  1.1320562+02      VE  2.4003330+04   GAMDE  1.7286916-02    AZDE  6.0393971+01
    HP  1.5350495+02    HAPO  1.6229985+02     INC  2.8532484+01     RAN  1.5133744+02     APF  1.6280038+01      MA -2.5380424+00
   HPM  1.5694119+02   HAPOM  1.6574310+02      AM  3.6052731+03     ECC  1.2207031-03    PERM  1.5082619+00   ALTEQ  1.5350839+02
CTRLIM  7.3201768+01  LIMSUN -1.2310316+01  DTRISE  7.5788021-02   DTSET -4.8174560-01     PER  1.5061037+00      TA  3.5745576+02
  DELX  5.0754578+00    DELY  3.2376468+01    DELZ -1.6794483+01   DELDX -2.4599603+02   DELDY  7.9236824+01   DELDZ  2.6529957+01
 RANGE  3.6824610+01     ELV  3.1826915+00     DAZ  1.7996516+02   RRATE  2.3661098+01  ELVDOT -1.3329645+00  DAZDOT  1.5784551-01


IUS SRB    BURN   DVIDEL  9.0788512+03  DWPRCS  0.0000000     DWPMAN -2.1568978+04   DTHRS  4.0825784-02   DTSEC  1.4697282+02

                                          END IUS 1ST STAGE BURN

                 GET      0 DAYS,  5 HRS, 47 MINS, 33.260 SECS                  GETHRS  5.7925723+00  GETSEC  2.0853260+04
                 GMT   1 JAN 1981, 20 HRS, 37 MINS, 35.660 SECS

IUS ACTIVE STATE     GMT  1.3124022+04   WPRCS  2.3400000+02   WPMAN  6.0580225+03   TBMAN  4.0825784-02  CDAREA  0.0000000
     X -3.5284436+03       Y  3.5526789+02       Z  7.0995972+02      DX -3.6651840+03      DY -3.1338865+04      DZ  1.1698863+04
     R  3.6171398+03     DEC  1.1319306+01      RA  1.7425126+02       V  3.3723707+04    BETA  8.5147417+01      AZ  6.9671042+01
   ALT  1.7365244+02     LAT  1.1390005+01     LON  1.2344529+02      VE  3.2258259+04   GAMDE  5.0990357+00    AZDE  6.8912532+01
    HP  1.4361784+02    HAPO  2.5220414+04     INC  2.2977663+01     RAN  1.4608167+02     APF  1.9086459+01      MA  8.7631035-01
   HPM  1.5790134+02   HAPOM  2.5331340+04      AM  1.6188352+04     ECC  7.7752940-01    PERM  1.4350713+01   ALTEQ  1.7320889+02
CTRLIM  7.2197191+01  LIMSUN -3.1303673+00  DTRISE  9.9999990+09   DTSET  9.9999990+09     PER  1.4267812+01      TA  1.1096517+01
THRMAG  4.2600000+04     ISP  2.9028000+02    WDOT -5.2831748+05     TUX -3.3203281-01     TUY -9.3886086-01     TUZ  9.1074148-02
TUXLVM  9.2307902-01  TUYLVM  2.9261767-01  TUZLVM -2.4959967-01     PCM  1.4453824+01   . YAW  1.7586706+01

ORB PASIVE STATE     GMT  1.7365305+05   WPRCS  7.0992312+03   WPMAN  6.9684529+03   TBMAN  5.8650129-02  CDAREA  6.2230000+03
     X -3.4992822+03       Y  4.7553962+02       Z  6.8566187+02      DX -9.1872378+02      DY -2.2609208+04      DZ  1.1119129+04
     R  3.5973943+03     DEC  1.0987778+01      RA  1.7226112+02       V  2.5391711+04    BETA  9.0004922+01      AZ  6.3506379+01
   ALT  1.5388145+02     LAT  1.1056891+01     LON  1.2145516+02      VE  2.4001479+04   GAMDE  2.7411739-02    AZDE  6.1839879+01
    HP  1.5345161+02    HAPO  1.6184394+02     INC  2.8528812+01     RAN  1.5133476+02     APF  2.7753135+01      MA -4.2227786+00
   HPM  1.5666125+02   HAPOM  1.6501035+02      AM  3.6047667+03     ECC  1.1580607-03    PERM  1.5079442+00   ALTEQ  1.5346335+02
CTRLIM  7.3204145+01  LIMSUN -5.8510609+00  DTRISE  3.5029948-02   DTSET -5.2261662-01     PER  1.5059444+00      TA  3.5576741+02
  DELX  2.9661415+01    DELY  1.2027173+02    DELZ -2.4297842+01   DELDX  2.7664652+03   DELDY  8.5296572+03   DELDZ -7.7975349+02
 RANGE  1.2623578+02     ELV -9.9879392+00     DAZ -1.6931408+02   RRATE  8.9267889+03  ELVDOT -4.3714295+02  DAZDOT  2.9732003+02
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B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Continued)

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                                      BEGIN IUS 2ND STAGE BURN

                  GET      0 DAYS,  9 HRS,  5 MINS, 23,972 SECS                GETHRS  9,0899922+00  GETSEC  3,2723972+04
                  GMT   1 JAN 1981, 23 HRS, 55 MINS, 26,372 SECS

IUS ACTIVE STATE     GMT  1,0665022+04   WPRCS  2,3400000+02   WPMAN  6,0580225+03   TBMAN  4,0825784-02  CDAREA  0,0000000
     X  1,8204801+04       Y -1,3575543+04       Z  4,5381103+02      DX  7,4516887+03      DY  5,8999027+02      DZ -1,9702348+03
     R  2,2713788+04     DEC  1,1448196+00      RA -3,6712344+01       V  7,7313230+03    BETA  4,3797857+01      AZ  1,1294545+02
   ALT  1,9264856+04     LAT  1,1459823+00     LON -1,3711502+02      VE  7,8647546+03   GAMDE  4,5197049+01    AZDE -1,1211340+02
    HP  1,4524397+02    HAPO  2,5094868+04     INC  2,2972947+01     RAN  1,4548959+02     APF  1,9213417+01      MA  8,4566753+01
   HPM  1,4530688+02   HAPOM  2,5095367+04      AM  1,6064268+04     ECC  7,7657010-01    PERM  1,4186032+01   ALTEQ  1,9264855+04
CTRLIM  8,7209898+00  LIMSUN  1,2486947+02  DTRISE  9,9999990+09   DTSET  9,9999990+09     PFR  1,4185659+01      TA  1,5785229+02
THRMAG  1,7430000+04     ISP  2,9455000+02    WDOT -2,1303004+05     TUX -1,7749720-01     TUY  9,4102369-01     TUZ  2,8804368-01
TUXLVH  4,7920116-01  TUYLVH -5,3089944-01  TUZLVH  6,9893635-01     PCH -4,4341731+01     YAW -4,7929917+01

IUS SRB    BURN     DVIDEL  7,9519808+03  DWPRCS  0,0000000      DWPMAN -6,0566466+03   DTHRS  2,8430939-02   DTSEC  1,0235138+02

                                      END IUS 2ND STAGE BURN

                  GET      0 DAYS,  9 HRS,  7 MINS,  6,323 SECS                GETHRS  9,1184231+00  GETSEC  3,2826323+04
                  GMT   1 JAN 1981, 23 HRS, 57 MINS,  8,723 SECS

IUS ACTIVE STATE     GMT  4,6083759+03   WPRCS  2,3400000+02   WPMAN  1,3758545+00   TBMAN  6,9256723-02  CDAREA  0,0000000
     X  1,8319564+04       Y -1,3510915+04       Z  4,3716790+02      DX  5,9796860+03      DY  8,1179277+03      DZ  3,1481700+02
     R  2,2767133+04     DEC  1,1002446+00      RA -3,6409253+01       V  1,0087443+04    BETA  8,9999442+01      AZ  8,8211259+01
   ALT  1,9323203+04     LAT  1,1013594+00     LON -1,3723956+02      VE  3,1488958+02   GAMDE  1,9010182-02    AZDE -5,8472918-01
    HP  1,9323083+04    HAPO  1,9323617+04     INC  2,0999389+00     RAN -6,7994798+01     APF -2,4781756+01      MA  5,6583357+01
   HPM  1,9323913+04   HAPOM  1,9323913+04      AM  2,2767844+04     ECC  0,0000000        PERM  2,3936044+01   ALTEQ  1,9323202+04
CTRLIM  8,7003963+00  LIMSUN  1,2466407+02  DTRISE  9,9999990+09   DTSET  9,9999990+09     PFR  2,3935158+01      TA  3,1602721+01
THRMAG  1,7430000+04     ISP  2,9455000+02    WDOT -2,1303004+05     TUX -1,7749720-01     TUY  9,4102369-01     TUZ  2,8804368-01
TUXLVH  6,6107279-01  TUYLVH -2,8096045-01  TUZLVH  6,9573268-01     PCH -4,4085632+01     YAW -2,3025824+01
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B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Continued)

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BEGIN SAT DEPLOYMENT

GET 0 DAYS, 9 HRS, 12 MINS, 6.322 SECS GETHRS 9.2017560+00 GETSEC 3.3126321+04
GMT 2 JAN 1981, 0 HRS, 2 MINS, 8.721 SECS

IUS ACTIVE STATE		GMT	4.6083759+03	WPRCS	2.3400000+02	WPMAN	1.3758545+00	TRMAN	6.9256723-02	CDAREA	0.0000000
X	1.8610395+04	Y	-1.3106904+04	Z	4.5260560+02	DX	5.8006979+03	DY	8.2469344+03	DZ	3.1050305+02
R	2.2767138+04	DEC	1.1391023+00	RA	-3.5156221+01	V	1.0087439+04	BETA	8.9999494+01	AZ	8.8235753+01
ALT	1.9323208+04	LAT	1.1402565+00	LON	-1.3723995+02	VE	3.1057669+02	GAMDE	1.7617180-02	AZDE	-5.4452983-01
HP	1.9323100+04	HAPO	1.9323589+04	INC	2.0999318+00	RAN	-6.7994919+01	APF	-2.2970415+01	MA	5.5825638+01
HPM	1.9323907+04	HAPOM	1.9323907+04	AM	2.2767838+04	ECC	0.0000000	PERM	2.3936034+01	ALTEQ	1.9323207+04
CTRLIM	8.7003945+00	LIMSUN	1.2359958+02	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3935149+01	TA	3.2856238+01

END SAT DEPLOYMENT

GET 0 DAYS, 9 HRS, 12 MINS, 6.322 SECS GETHRS 9.2017560+00 GETSEC 3.3126321+04
GMT 2 JAN 1981, 0 HRS, 2 MINS, 8.721 SECS

IUS ACTIVE STATE		GMT	1.8703759+03	WPRCS	2.3400000+02	WPMAN	1.3758545+00	TRMAN	6.9256723-02	CDAREA	0.0000000
X	1.8610395+04	Y	-1.3106904+04	Z	4.5260560+02	DX	5.8006979+03	DY	8.2469344+03	DZ	3.1050305+02
R	2.2767138+04	DEC	1.1391023+00	RA	-3.5156221+01	V	1.0087439+04	BETA	8.9999494+01	AZ	8.8235753+01
ALT	1.9323208+04	LAT	1.1402565+00	LON	-1.3723995+02	VE	3.1057669+02	GAMDE	1.7617180-02	AZDE	-5.4452983-01
HP	1.9323100+04	HAPO	1.9323589+04	INC	2.0999318+00	RAN	-6.7994919+01	APF	-2.2970415+01	MA	5.5825638+01
HPM	1.9323907+04	HAPOM	1.9323907+04	AM	2.2767838+04	ECC	0.0000000	PERM	2.3936034+01	ALTEQ	1.9323207+04
CTRLIM	8.7003945+00	LIMSUN	1.2359958+02	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3935149+01	TA	3.2856238+01

SAT PASIVE STATE		GMT	2.7380000+03	WPRCS	0.0000000	WPMAN	0.0000000	TRMAN	0.0000000	CDAREA	0.0000000
X	1.8610395+04	Y	-1.3106904+04	Z	4.5260560+02	DX	5.8012729+03	DY	8.2477520+03	DZ	3.1055383+02
R	2.2767138+04	DEC	1.1391023+00	RA	-3.5156221+01	V	1.0088439+04	BETA	8.9999494+01	AZ	8.8235753+01
ALT	1.9323208+04	LAT	1.1402565+00	LON	-1.3723995+02	VE	3.1059958+02	GAMDE	1.7608883-02	AZDE	-3.6010388-01
HP	1.9323202+04	HAPO	1.9332517+04	INC	2.0999318+00	RAN	-6.7994919+01	APF	3.0377325+01	MA	2.4776987+00
HPM	1.9323766+04	HAPOM	1.9333079+04	AM	2.2772353+04	ECC	2.0450116-04	PERM	2.3943156+01	ALTEQ	1.9323207+04
CTRLIM	8.7003945+00	LIMSUN	1.2359958+02	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3942270+01	TA	2.4779000+00
DELX	0.0000000	DELY	0.0000000	DELZ	0.0000000	DELDX	5.7500023-01	DELDY	8.1756830-01	DELDZ	3.0781156-02

B.2 Orbiter and IUS Mission Profiles IUS Fourth Ascending Node Transfer (Concluded)

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BEGIN ORB DORBIT BURN

```
GET    1 DAYS, 1 HRS, 1 MINS, 33.880 SECS          GETHRS 2.5026078+01  GETSEC 9.0093880+04
GMT    2 JAN 1981, 15 HRS, 51 MINS, 36.279 SECS

ORB ACTIVE STATE   GMT 1.7365305+05   WPRCS 7.0993445+03   WPMAN 6.9684529+03   TBMAN 5.8456101-02  CDAREA 6.2230000+03
X -9.8217248+02    Y 3.2623804+03     Z -1.1519000+03      DX -2.3430041+04     DY -3.8777617+03    DZ 8.4907041+03
R 3.5964810+03     DEC -1.8680279+01  RA 1.0075495+02      V 2.5393633+04       BETA 8.9996762+01   AZ 6.8052238+01
ALT 1.5373632+02   LAT -1.8792313+01  LON 1.2665653+02     VE 2.4000098+04      GAMDE -4.0879488-02 AZDE 6.6705177+01
HP 1.5254460+02    HAPO 1.6018245+02  INC 2.8518437+01     RAN 1.4523346+02     APF -4.5189536+01   MA 3.0511149+00
HPM 1.5503171+02   HAPOM 1.6264905+02 AM 3.6027713+03      ECC 1.0571599-03     PERM 1.5066923+00   ALTEQ 1.5255014+02
CTRLIM 7.3252413+01 LIMSUN -3.1548673+01 DTRISE 3.4446406-01 DTSET -2.2244692-01 PER 1.5051389+00   TA 3.0575303+00
THRMAG 1.2000000+04 ISP 3.1320000+02  WDOT -1.3793104+05   TUX 8.7016899-01     TUY 2.8929900-01    TUZ -3.9888848-01
TUXLVM -9.8824632-01 TUYLVM 1.1640787-04 TUZLVM -1.5254616-01 PCH 8.7745097+00  YAW 1.7999325+02

ORB OMS   BURN   DVIDEL 2.9735177+02   DWPRCS 0.0000000   DWPMAN -5.0493301+03   DTHRS 3.6607504-02   DTSEC 1.3178701+02
```

END ORB DORHIT BURN

```
GET    1 DAYS, 1 HRS, 3 MINS, 45.667 SECS          GETHRS 2.5062685+01  GETSEC 9.0225666+04
GMT    2 JAN 1981, 15 HRS, 53 MINS, 48.066 SECS

ORB ACTIVE STATE   GMT 1.6860372+05   WPRCS 7.0993445+03   WPMAN 1.9191228+03   TBMAN 9.5063604-02  CDAREA 6.2230000+03
X -1.4740950+03    Y 3.1413593+03     Z -9.4542639+02      DX -2.1840555+04     DY -7.2596151+03    DZ 1.0011066+04
R 3.5965157+03     DEC -1.5240596+01  RA 1.1513850+02      V 2.5098479+04       BETA 9.0047447+01   AZ 6.5594856+01
ALT 1.5338289+02   LAT -1.5334275+01  LON 1.3446947+02     VE 2.3706882+04      GAMDE -9.1211989-02 AZDE 6.4059428+01
HP -2.7714080+00   HAPO 1.5263939+02  INC 2.8523712+01     RAN 1.4522486+02     APF 1.4449745+02    MA -1.7780394+02
HPM -1.2210083-01  HAPOM 1.5540881+02 AM 3.5215743+03      ECC 2.2082584-02     PERM 1.4560450+00   ALTEQ 1.5258481+02
CTRLIM 7.3250576+01 LIMSUN -3.3391538+01 DTRISE 3.3129001-01 DTSET 1.1800411+00 PER 1.4543651+00    TA 1.8210169+02
THRMAG 1.2000000+04 ISP 3.1320000+02  WDOT -1.3793104+05   TUX 8.7016899-01     TUY 2.8929900-01    TUZ -3.9888848-01
TUXLVM -9.9999958-01 TUYLVM 1.1548400-07 TUZLVM -8.8977348-04 PCH 5.0980274-02  YAW 1.7999999+02
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BEGIN ATMOSPHERIC FLT

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GET    1 DAYS, 1 HRS, 26 MINS, 29.480 SECS         GETHRS 2.5441522+01  GETSEC 9.1589480+04
GMT    2 JAN 1981, 16 HRS, 16 MINS, 31.880 SECS

ORB ACTIVE STATE   GMT 1.6860372+05   WPRCS 7.0993445+03   WPMAN 1.9191228+03   TBMAN 9.5063604-02  CDAREA 6.2230000+03
X -3.0167321+03    Y -1.0885267+03    Z 1.4210871+03       DX 1.1613000+04      DY -2.2099854+04    DZ 6.2505882+03
R 3.5078556+03     DEC 2.3698372+01   RA -1.6015905+02     V 2.5735873+04       BETA 9.1329353+01   AZ 7.3978145+01
ALT 6.5823968+01   LAT 2.4038522+01   LON -1.4650620+02    VE 2.4373615+04      GAMDE -1.3628168+00 AZDE 7.3052632+01
HP -8.1654001+00   HAPO 1.5632483+02  INC 2.8507796+01     RAN 1.4517112+02     APF 1.4232049+02    MA -8.1578201+01
HPM -6.3378906+00  HAPOM 1.5823520+02 AM 3.5198796+03      ECC 2.3377660-02     PERM 1.4549941+00   ALTEQ 6.3424652+01
CTRLIM 7.9044990+01 LIMSUN 7.4517231+00 DTRISE -4.6047211-02 DTSET 8.0116844-01 PER 1.4538355+00    TA 2.7576118+02
```

B.3 Orbiter and IUS Mission Profiles IUS Fifth Descending Node Transfer

BEGIN IUS 1ST STAGE BURN

GET 0 DAYS, 6 HRS, 30 MINS, 5.063 SECS — GETHRS 6.5014063+00 — GETSEC 2.3405062+04
GMT 1 JAN 1981, 21 HRS, 20 MINS, 7.462 SECS

IUS ACTIVE STATE		GMT	3.4093000+04	WPRCS	2.3400000+02	WPMAN	2.7627000+04	THMAN	0.0000000	CDAREA	0.0000000
X	3.4271941+03	Y	-9.9445517+02	Z	-4.2470829+02	DX	4.9474300+03	DY	2.1966401+04	DZ	-1.1755573+04
R	3.5951400+03	DEC	-6.7853858+00	RA	-1.6257977+01	V	2.5400657+04	BETA	9.0003257+01	AZ	1.1777996+02
ALT	1.5136782+02	LAT	-6.8287545+00	LON	-7.7725561+01	VE	2.4012517+04	GAMDE	1.7939947-02	AZDE	1.1953931+02
HP	1.5120436+02	HAPO	1.6013806+02	INC	2.8532412+01	RAN	1.5110075+02	APF	-1.6305081+02	MA	-2.6216131+00
HPM	1.5463828+02	HAPOM	1.6356501+02	AM	3.6030329+03	ECC	1.2388704-03	PERM	1.5066563+00	ALTEQ	1.5120914+02
CTRLIM	7.3323581+01	LIMSUN	4.5660889+01	DTRISE	-6.7920466-01	DTSET	2.6068715-01	PER	1.5047048+00	TA	3.5737189+02
THRMAG	4.2000000+04	ISP	2.9020000+02	WDOT	-5.2031748+05	TUX	3.3560166-01	TUY	9.3762169-01	TUZ	-9.0756324-02
TUXLVM	9.1822563-01	TUYLVM	-3.8982450-01	TUZLVM	-6.9986997-02	PCH	4.0132404+00	YAW	-2.3003212+01		
ORB PASIVE STATE		GMT	1.7365305+05	WPRCS	7.0492312+03	WPMAN	6.9684529+03	TRMAN	5.6050129-02	CDAREA	6.2230000+03
X	3.4219895+03	Y	-1.0317504+03	Z	-4.0300282+02	DX	5.1927444+03	DY	2.1086375+04	DZ	-1.1782012+04
R	3.5973600+03	DEC	-6.5123450+00	RA	-1.6776468+01	V	2.5392790+04	BETA	9.0003009+01	AZ	1.1784037+02
ALT	1.5357513+02	LAT	-6.5534767+00	LON	-7.8240052+01	VE	2.4003863+04	GAMDE	1.7385474-02	AZDE	1.1960595+02
HP	1.5342507+02	HAPO	1.6234061+02	INC	2.8532465+01	RAN	1.5110145+02	APF	-1.6383092+02	MA	-2.4272648+00
HPM	1.5688153+02	HAPOM	1.6577047+02	AM	3.6052572+03	ECC	1.2328497-0[illegible]	PERM	1.5082519+00	ALTEQ	1.5342911+02
CTRLIM	7.3205953+01	LIMSUN	4.6150747+01	DTRISE	-6.7010374-01	DTSET	2.7008349-01	PER	1.5060937+00	TA	3.5756071+02
DELX	-5.2096303+00	DELY	-3.2301268+01	DELZ	1.6765478+01	DELDX	2.4530[illegible]8+02	DELDY	-8.0020669+01	DELDZ	-2.0435604+01
RANGE	3.6704023+01	ELV	3.1695025+00	DAZ	-1.7497012+02	RRATE	2.3493639+01	ELVDOT	-1.3217278+00	DAZDOT	-7.2562404-02

IUS SRB BURN	DVIDEL	9.0791580+03	DWPRCS	0.0000000	DWPMAN	-2.1569409+04	DTHRS	4.0620559-02	DTSEC	1.4697561+02

END IUS 1ST STAGE BURN

GET 0 DAYS, 6 HRS, 32 MINS, 32.038 SECS — GETHRS 6.5422328+00 — GETSEC 2.3552038+04
GMT 1 JAN 1981, 21 HRS, 22 MINS, 34.437 SECS

IUS ACTIVE STATE		GMT	1.3123591+04	WPRCS	2.3400000+02	WPMAN	6.0575913+03	TRMAN	4.0620559-02	CDAREA	0.0000000
X	3.5273604+03	Y	-3.6979770+02	Z	-7.0490637+02	DX	3.8119011+03	DY	3.1325235+04	DZ	-1.1890344+04
R	3.6170413+03	DEC	-1.1318756+01	RA	-5.9840527+00	V	3.3724233+04	BETA	8.5152838+01	AZ	1.1012491+02
ALT	1.7355391+02	LAT	-1.1389454+01	LON	-6.8060512+01	VE	3.2258770+04	GAMDE	5.0933594+00	AZDE	1.1108319+02
HP	1.4558612+02	HAPO	2.5220586+04	INC	2.2973905+01	RAN	1.4584149+02	APF	-1.6089755+02	MA	8.7724759-01
HPM	1.5747104+02	HAPOM	2.5331521+04	AM	1.6188427+04	ECC	7.7753232-01	PERM	1.4350813+01	ALTEQ	1.7311041+02
CTRLIM	7.2202049+01	LIMSUN	3.8474367+01	DTRISE	6.5886265-01	DTSET	9.9999990+09	PER	1.4267965+01	TA	1.1086005+01
THRMAG	4.2000000+04	ISP	2.9020000+02	WDOT	-5.2031748+05	TUX	3.3560166-01	TUY	9.3762169-01	TUZ	-9.0756324-02
TUXLVM	9.2311329-01	TUYLVM	-2.9262201-01	TUZLVM	-2.4423306-01	PCH	1.4432130+01	YAW	-1.7599618+01		
ORB PASIVE STATE		GMT	1.7365305+05	WPRCS	7.0492312+03	WPMAN	6.9684529+03	TRMAN	5.6050129-02	CDAREA	6.2230000+03
X	3.4972244+03	Y	-4.8990393+02	Z	-6.8506413+02	DX	1.0125283+03	DY	2.2005670+04	DZ	-1.1119307+04
R	3.5975211+03	DEC	-1.0986040+01	RA	-7.9743107+00	V	2.5392183+04	BETA	9.0004667+01	AZ	1.1049352+02
ALT	1.5580837+02	LAT	-1.1057157+01	LON	-7.0055969+01	VE	2.4001977+04	GAMDE	2.7081052-02	AZDE	1.1815994+02
HP	1.5537986+02	HAPO	1.6189058+02	INC	2.8528812+01	RAN	1.5109879+02	APF	-1.5252077+02	MA	-3.9487906+00
HPM	1.5657968+02	HAPOM	1.6500883+02	AM	3.6047543+03	ECC	1.1772035-03	PERM	1.5079364+00	ALTEQ	1.5534023+02
CTRLIM	7.3208006+01	LIMSUN	3.9687122+01	DTRISE	-7.1698884-01	DTSET	2.2645250-01	PER	1.5059565+00	TA	3.5004193+02
DELX	-3.0135957+01	DELY	-1.2010623+02	DELZ	2.4242238+01	DELDX	-2.7493728+03	DELDY	-8.5195618+03	DELDZ	7.7703722+02
RANGE	1.2617990+02	ELV	-4.9794132+00	DAZ	1.6924823+02	RRATE	8.9273431+03	ELVDOT	-4.3672987+02	DAZDOT	-2.9725992+02

B.3 Orbiter and IUS Mission Profiles IUS Fifth Descending Node Transfer (Continued)

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BEGIN IUS 2ND STAGE BURN

GET 0 DAYS, 9 HRS, 50 MINS, 22.945 SECS GETHRS 9.8397070+00 GETSEC 3.5422945+04
GMT 2 JAN 1981, 0 HRS, 40 MINS, 25.345 SECS

IUS ACTIVE STATE		GWT	1.0664591+04	WPRCS	2.3400000+02	WPMAN	6.0575913+03	TRMAN	4.0826559-02	CDAREA	0.0000000
X	-1.8151429+04	Y	1.3646921+04	Z	-4.5118684+02	DX	-7.4537599+03	DY	-5.6099723+02	DZ	1.9745881+03
M	2.2713742+04	DEC	-1.1381984+00	RA	1.4316279+02	V	7.7312515+03	BETA	4.3798050+01	AZ	6.7057375+01
ALT	1.9269863+04	LAT	-1.1343544+00	LON	3.1383596+01	VE	7.8645829+03	GAMDE	4.5197643+01	AZDE	-6.7889147+01
HP	1.4520348+02	HAPO	2.509 675+04	INC	2.2 59317+01	RAN	1.4574955+02	APF	-1.6077048+02	MA	8.4567941+01
HPM	1.4520636+02	HAPOM	2.509 75+04	AM	1.6064152+04	ECC	7.7657101-01	PERM	1.4185878+01	ALTEQ	1.9269862+04
CTRLIM	8.7204872+00	LIMSUN	3.7468565+01	DTRISE	-2.6366987+00	DTSET	9.9999990+09	PER	1.4185505+01	TA	1.5785274+02
THRMAG	1.7430000+04	ISP	2.9455000+02	WDOT	-2.1303004+05	TUX	1.7378251-01	TUY	-9.4167317-01	TUZ	-2.8818618-01
TUXLVH	4.7919000-01	TUYLVH	5.3092001-01	TUZLVH	6.9892838-01	PCH	-4.4341092+01	YAW	4.7931685+01		

IUS SRB BURN	DVIDEL	7.9520184+03	DWPRCS	0.0000000	DWPMAN	-6.0564200+03	DTHRS	2.8429866-02	DTSEC	1.0234752+02

END IUS 2ND STAGE BURN

GET 0 DAYS, 9 HRS, 52 MINS, 5.293 SECS GETHRS 9.8681369+00 GETSEC 3.5525292+04
GMT 2 JAN 1981, 0 HRS, 42 MINS, 7.692 SECS

IUS ACTIVE STATE		GWT	4.6081713+03	WPRCS	2.3400000+02	WPMAN	1.1712646+00	TRMAN	6.9256425-02	CDAREA	0.0000000
X	-1.8260438+04	Y	1.3582745+04	Z	-4.3454675+02	DX	-6.0114685+03	DY	-8.0443704+03	DZ	-3.1561641+02
M	2.2767137+04	DEC	-1.0436468+00	RA	1.4336587+02	V	1.0087427+04	BETA	8.9909626+01	AZ	9.1793289+01
ALT	1.9323207+04	LAT	-1.0947550+00	LON	3.1254064+01	VE	3.1568967+02	GAMDE	1.3046582-02	AZDE	-1.7940511+02
HP	1.9323119+04	HAPO	1.9323461+04	INC	2.1003702+00	RAN	-6.8001430+01	APF	1.5070368+02	MA	6.0679763+01
HPM	1.9323852+04	HAPOM	1.9323852+04	AM	2.2767762+04	ECC	0.0000000	PERM	2.3935947+01	ALTEQ	1.9323206+04
CTRLIM	8.7003949+00	LIMSUN	3.771 673+01	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3935063+01	TA	2.1138441+02
THRMAG	1.7430000+04	ISP	2.9455000+02	WDOT	-2.1303004+05	TUX	1.7378251-01	TUY	-9.4167317-01	TUZ	-2.8818618-01
TUXLVH	6.6107689-01	TUYLVH	2.8047020-01	TUZLVH	6.9572466-01	PCH	-4.4085008+01	YAW	2.3026412+01		

B.4 Orbiter and IUS Mission Profiles IUS Fifth Descending Node Transfer (Concluded)

BEGIN SAT DEPLOYMENT

GET 0 DAYS, 9 HRS, 57 MINS, 5.291 SECS
GMT 2 JAN 1981, 0 HRS, 47 MINS, 7.691 SECS

GETHRS 9.9514698+00 GETSFC 3.5825291+04

IUS ACTIVE STATE		GWT	4.6081713+03	WPRCS	2.3400000+02	WPMAN	1.1712646+00	TRMAN	6.9256425-02	CDAREA	0.0000000
X	-1.8558850+04	Y	1.3179880+04	Z	-4.5002454+02	DX	-5.8329871+03	DY	-8.2240781+03	DZ	-3.1132743+02
R	2.2767140+04	DEC	-1.1320054+00	RA	1.4461889+02	V	1.0087424+04	BETA	8.9999683+01	AZ	9.1768936+01
ALT	1.9323210+04	LAT	-1.1337530+00	LON	3.1258667+01	VE	3.1140177+02	GAMDE	1.1443903-02	AZDE	-1.7944504+02
HP	1.9323134+04	HAPO	1.9323423+04	INC	2.1003621+00	RAN	-6.8001567+01	APF	1.5135965+02	MA	6.1277654+01
HPM	1.9323841+04	HAPOM	1.9323841+04	AM	2.2767772+04	ECC	0.0000000	PERM	2.3935930+01	ALTEQ	1.9323209+04
CTRLIM	8.7003937+00	LIMSUN	3.8777735+01	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3935045+01	TA	2.1263795+02

END SAT DEPLOYMENT

GET 0 DAYS, 9 HRS, 57 MINS, 5.291 SECS
GMT 2 JAN 1981, 0 HRS, 47 MINS, 7.691 SECS

GETHRS 9.9514698+00 GETSEC 3.5825291+04

IUS ACTIVE STATE		GWT	1.8701713+03	WPRCS	2.3400000+02	WPMAN	1.1712646+00	TRMAN	6.9256425-02	CDAREA	0.0000000
X	-1.8558850+04	Y	1.3179880+04	Z	-4.5002454+02	DX	-5.8329871+03	DY	-8.2240781+03	DZ	-3.1132743+02
R	2.2767140+04	DEC	-1.1320054+00	RA	1.4461889+02	V	1.0087424+04	BETA	8.9999683+01	AZ	9.1768936+01
ALT	1.9323210+04	LAT	-1.1337530+00	LON	3.1258607+01	VE	3.1140177+02	GAMDE	1.1443903-02	AZDE	-1.7944504+02
HP	1.9323134+04	HAPO	1.9323423+04	INC	2.1003621+00	RAN	-6.8001567+01	APF	1.5135965+02	MA	6.1277654+01
HPM	1.9323841+04	HAPOM	1.9323841+04	AM	2.2767772+04	ECC	0.0000000	PERM	2.3935930+01	ALTEQ	1.9323209+04
CTRLIM	8.7003937+00	LIMSUN	3.8777735+01	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3935045+01	TA	2.1263795+02
SAT PASIVE STATE		GWT	2.7380000+03	WPRCS	0.0000000	WPMAN	0.0000000	TRMAN	0.0000000	CDAREA	0.0000000
X	-1.8558850+04	Y	1.3179880+04	Z	-4.5002454+02	DX	-5.8335653+03	DY	-8.2248933+03	DZ	-3.1135829+02
R	2.2767140+04	DEC	-1.1320054+00	RA	1.4461889+02	V	1.0088424+04	BETA	8.9999683+01	AZ	9.1768936+01
ALT	1.9323210+04	LAT	-1.1337530+00	LON	3.1258607+01	VE	3.1142456+02	GAMDE	1.1437339-02	AZDE	-1.7962847+02
HP	1.9323207+04	HAPO	1.9332380+04	INC	2.1003621+00	RAN	-6.8001567+01	APF	-1.4893863+02	MA	1.5759421+00
HPM	1.9323770+04	HAPOM	1.9332942+04	AM	2.2772287+04	ECC	2.0134092-04	PERM	2.3943051+01	ALTEQ	1.9323209+04
CTRLIM	8.7003937+00	LIMSUN	3.8777735+01	DTRISE	9.9999990+09	DTSET	9.9999990+09	PER	2.3942165+01	TA	1.5759425+00
DELX	0.0000000	DELY	0.0000000	DELZ	0.0000000	DELDX	-5.7816171-01	DELDY	-8.1522967-01	DELDZ	-3.0862359-02

APPENDIX C

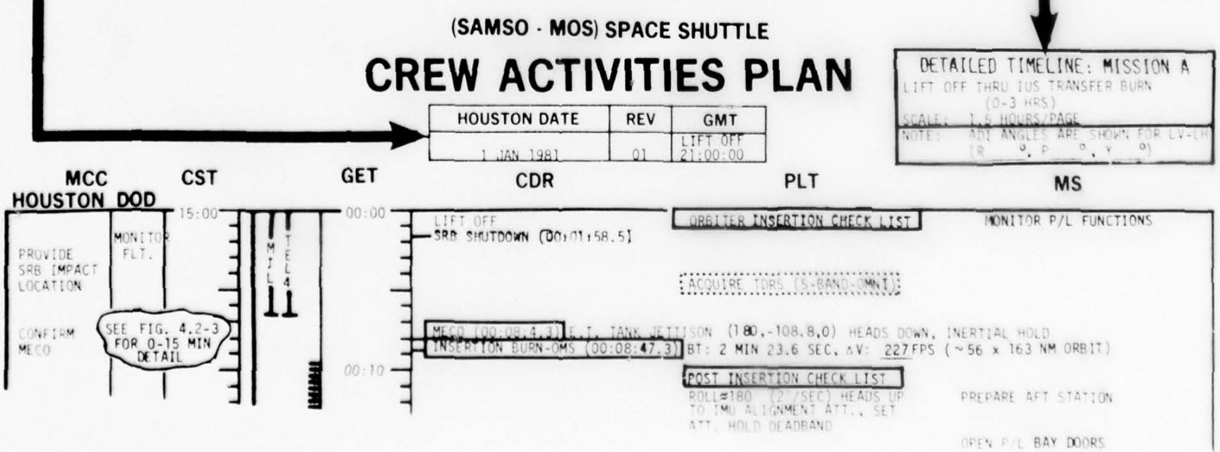
CREW ACTIVITIES PLAN FORMAT

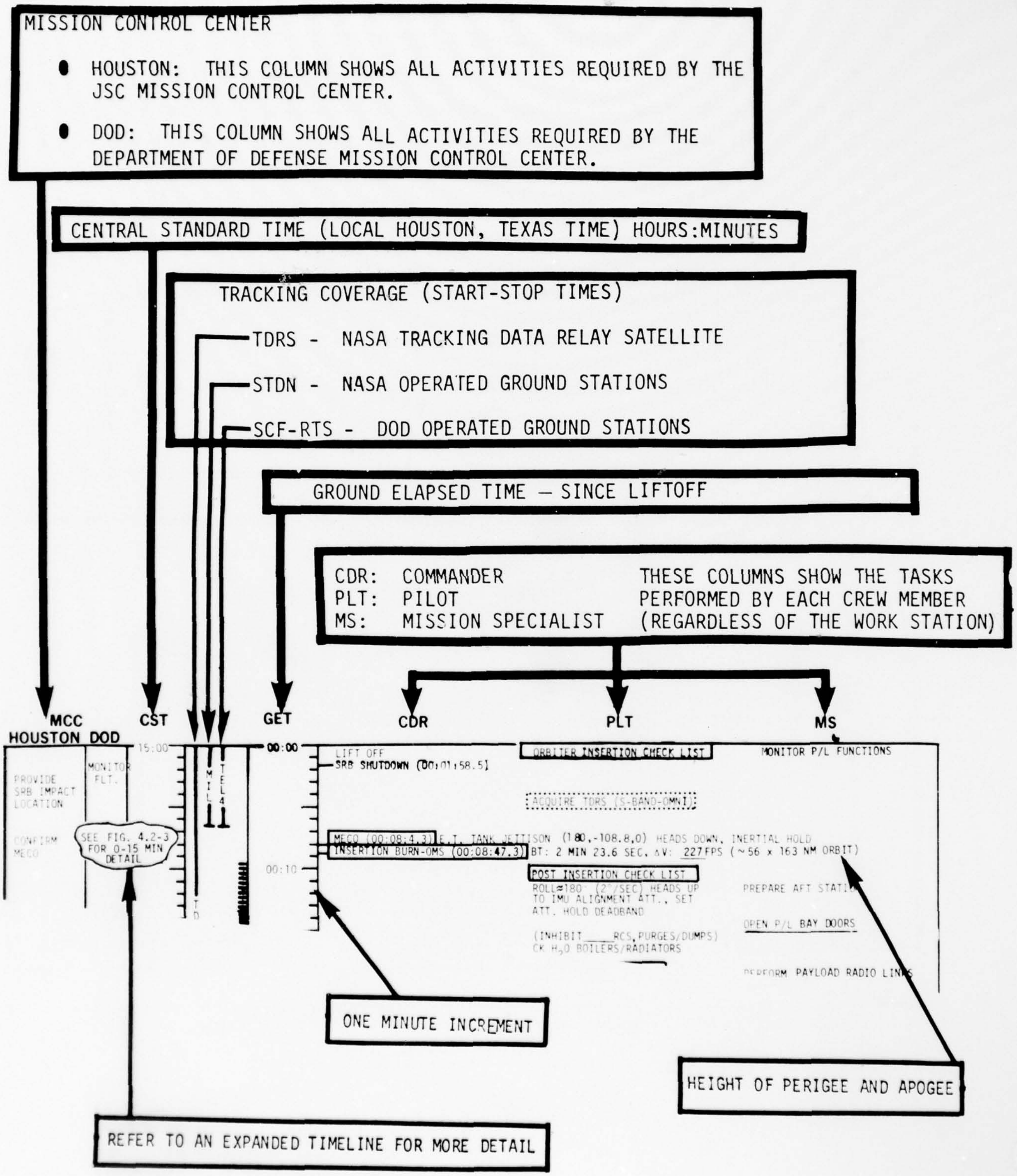
(U) In order to ensure good communications between DOD and NASA mission planning and flight operations personnel, the DOD crew activity planning task uses similar timeline formats and conventions to those used by NASA.

C.1 TIMELINE HEADINGS

- HOUSTON DATE: THE HOUSTON, TEXAS DATE FOR THE START OF EACH PAGE OF THE TIMELINE.
- REV: THE ORBITAL REVOLUTION(S) SHOWN ON EACH TIMELINE PAGE.
- GMT: THE GREENWICH MEAN TIME AT THE START OF EACH PAGE OF THE TIMELINE.

- NAME OF THE TIMELINE, I.E.:
  - o SUMMARY (7.5 HOURS/PAGE)
  - o DETAILED (1.5 HOURS/PAGE)
  - o SEQUENCE (XX MINUTES/PAGE)
- MISSION: THE NAME OF THE MISSION COVERED BY THE TIMELINE.
- ADI ANGLES: THE ROLL, PITCH AND YAW ANGLES PRESENTED TO THE CREW IN THE LOCAL VERTICAL-LOCAL HORIZONTAL COORDINATE SYSTEM.




MISSION CONTROL CENTER
HOUSTON: THIS COLUMN SHOWS ALL ACTIVITIES REQUIRED BY THE JSC MISSION CONTROL CENTER.
DOD: THIS COLUMN SHOWS ALL ACTIVITIES REQUIRED BY THE DEPARTMENT OF DEFENSE MISSION CONTROL CENTER.
CENTRAL STANDARD TIME (LOCAL HOUSTON, TEXAS TIME) HOURS:MINUTES
TRACKING COVERAGE (START-STOP TIMES)
TDRS - NASA TRACKING DATA RELAY SATELLITE
STDN - NASA OPERATED GROUND STATIONS
SCF-RTS - DOD OPERATED GROUND STATIONS
GROUND ELAPSED TIME — SINCE LIFTOFF
CDR: COMMANDER
PLT: PILOT
MS: MISSION SPECIALIST
THESE COLUMNS SHOW THE TASKS PERFORMED BY EACH CREW MEMBER (REGARDLESS OF THE WORK STATION)
MCC
HOUSTON
DOD
CST
GET
CDR
PLT
MS
15:00
00:00
00:10
PROVIDE SRB IMPACT LOCATION
CONFIRM MECO
MONITOR FLT.
SEE FIG. 4.2-3 FOR 0-15 MIN DETAIL
T D
M I L
T E L 4
LIFT OFF
SRB SHUTDOWN (00:01:58.5)
ORBITER INSERTION CHECK LIST
MONITOR P/L FUNCTIONS
ACQUIRE TDRS (S-BAND-OMNI)
MECO (00:08:4.3) E.T. TANK JETTISON (180,-108.8,0) HEADS DOWN, INERTIAL HOLD
INSERTION BURN-OMS (00:08:47.3) BT: 2 MIN 23.6 SEC, ΔV: 227 FPS (~56 x 163 NM ORBIT)
POST INSERTION CHECK LIST
ROLL≈180° (2°/SEC) HEADS UP TO IMU ALIGNMENT ATT., SET ATT. HOLD DEADBAND
(INHIBIT ____ RCS, PURGES/DUMPS)
CK H2O BOILERS/RADIATORS
PREPARE AFT STATION
OPEN P/L BAY DOORS
PERFORM PAYLOAD RADIO LINKS
ONE MINUTE INCREMENT
HEIGHT OF PERIGEE AND APOGEE
REFER TO AN EXPANDED TIMELINE FOR MORE DETAIL

- ENGINE BURNS — GET OF BURN (HOURS:MINUTES:SECONDS)

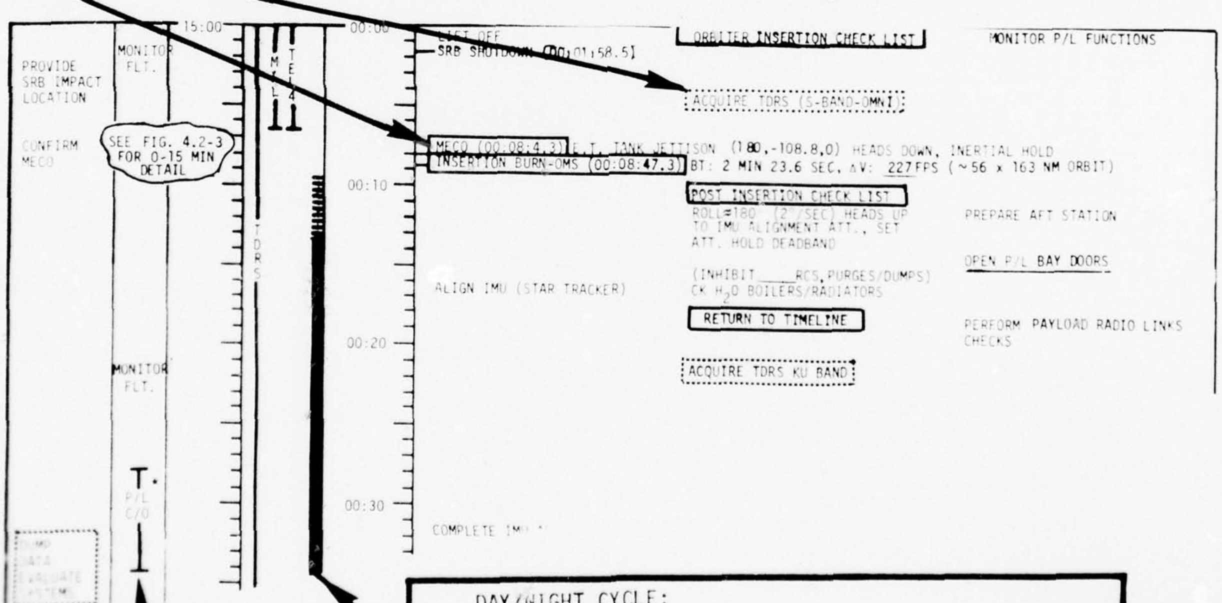
  ALL ENGINE BURNS ARE BOXED IN THE SUMMARY AND DETAILED TIMELINES.

- ACTIVITIES IN DOTTED BOX

  THESE ACTIVITIES ARE FOR INFORMATION AND ARE EITHER:
  a) NOT ESSENTIAL TO MISSION SUCCESS,
  b) CONTINGENCY ACTIVITIES, OR
  c) IUS/SAT ACTIVITIES PERFORMED IN CONCERT WITH ORBITER ACTIVITIES.

- CHECKLIST

  - THIS MEANS THAT THIS PORTION OF THE TIMELINE IS ACTUALLY FLOWN USING THE SPECIFIED CHECKLIST UNTIL A RETURN TO TIMELINE IS SHOWN OR ANOTHER CHECKLIST IS SPECIFIED.



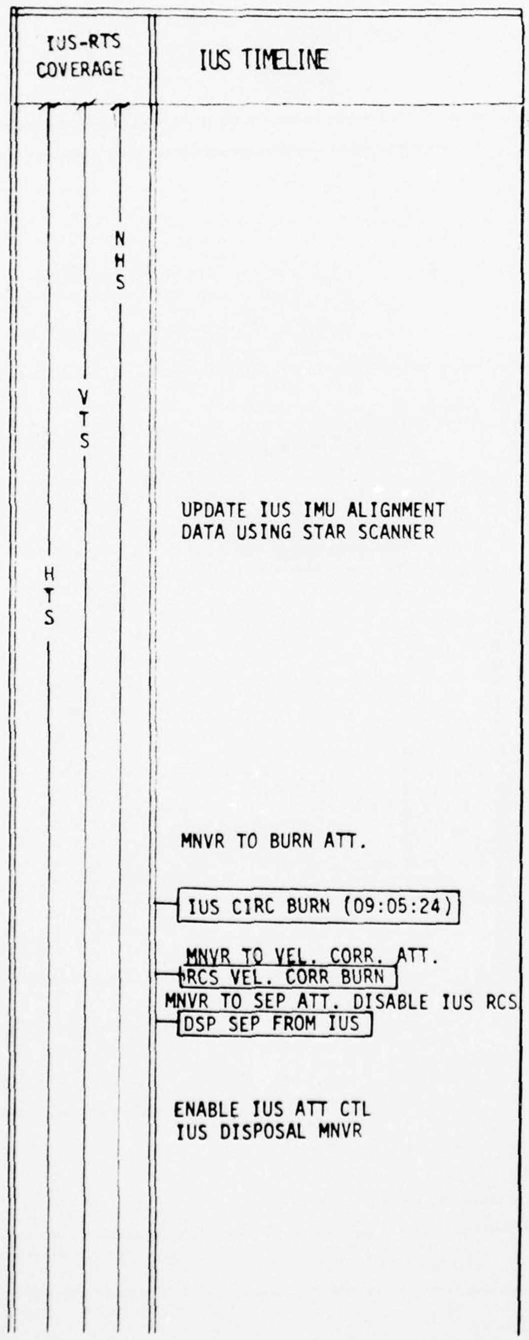
DAY/NIGHT CYCLE:
- BLACK MEANS DARKNESS
- NO LINE MEANS DAYLIGHT
- DOTTED LINE BETWEEN DAYLIGHT/DARKNESS

ESSENTIAL MCC-DOD ACTIVITY

MCC-H ACTION - IN DOTTED BOX NOT ESSENTIAL TO MISSION SUCCESS

IUS TIMELINE FORMAT

The timeline for the detached IUS is shown on the right side of the crew activity timelines. The RTS-COVERAGE column shows the RTS tracking available for IUS flight operations.



APPENDIX D:

ACRONYMS

ACT	Activate
AFSCF	Air Force Satellite Control Facility
ANT	Antenna
AOS	Acquisition of Signal
APU	Auxiliary Power Unit
ATT	Attitude
BT	Burn Time
C&T	Communication and Tracking
C&W	Caution and Warning
CDR	Commander
CDRL	Contract Deliverable Requirements List
CIRC	Circularization (Burn)
CK	Check
C/L	Checklist
CMD	Command
C/O	Checkout
CONUS	Continental United States
CST	Central Standard Time
CTL	Control
DB	Deadband
D&C	Display and Controls
DOD	Department of Defense
DSP	Defense Support Program

ACRONYMS (Continued)

EAFB	Edwards Air Force Base
ET	External Tank
ETR	Eastern Test Range
FLTSATCOM	Fleet Satellite Communications
FSC	Fleet Satellite Communications
GET	Ground Elapsed Time
GLT	Generalized Linear Tangent (Guidance)
GMT	Greenwich Mean Time
GNC	Guidance, Navigation and Control
GPC	General Purpose Computer
GPS	Global Positioning System
GTS	Guam Tracking Station
HTS	Hawaii Tracking Station
H/W	Hardware
HYD	Hydraulic
I/O	Input/Output
IOS	Indian Ocean Station
IUS	Interim Upper Stage
IUS/SAT	Interim Upper Stage/Satellite
JSC	Johnson Space Center
KBPS	Kilobits Per Second
KSC	Kennedy Space Center
LOS	Loss of Signal; Line of Sight

ACRONYM (Continued)

LVLH	Local Vertical-Local Horizontal
MCC	Mission Control Center
ME	Main Engine
MECO	Main Engine Cutoff
MOS	Mission Operations System
MOSD	Mission Operations System Definition
MPS	Main Propulsion System
MS	Mission Specialist
MSC	Previous name for JSC
MSFC	Marshall Space Flight Center
MSS	Mission Specialist Station
NASA	National Aeronautics and Space Administration
NAV	Navigation
NHS	New Hampshire Station
NPL	Nominal Power Level
OMS	Orbital Maneuvering System
ORB	Orbiter Vehicle
OWD	One Way Doppler
PCM	Pulse Code Modulation
P/L	Payload
PLT	Pilot
PMT	Propellant Mean Temperature
PSS	Payload Specialist Station
RCS	Reaction Control System
RF	Radio Frequency
RI	Rockwell International Corporation

ACRONYMS (Continued)

RMS	Remote Manipulator System
RTS	Remote Tracking Station
SAMSO	Space and Missile Systems Organization
SAT	Satellite
SCF	Satellite Control Facility
SGLS	Space Ground Link System
SRB	Solid Rocket Booster
SRM	Solid Rocket Motor
SSME	Space Shuttle Main Engine
STC	Satellite Test Center
STDN	Space Tracking Data Network (NASA)
STS	Space Transportation System
SV	State Vector
SVDS	Space Vehicle Dynamics Simulation
S/W, SW	Software
TBD	To Be Determined
TDRS	Tracking Data Relay Satellite
TDRSS	Tracking Data Relay Satellite System
TEL-4	Tracking Station at KSC
TLM	Telemetry
TR	Technical Report
TTS	Thule Tracking Station

ACRONYMS (Continued)

UMB	Umbilical
USAF	United States Air Force
VAFB	Vandenberg Air Force Base, California
VTS	Vandenberg Tracking Station
X-FER	Transfer
X-MITTER	Transmitter

APPENDIX E:

MISSION PLAN REVISIONS

Subsequent to development of the DSP Mission Plan presented in this report, several changes to the IUS configuration were tentatively adopted. These were:

1. Incorporation of an RF link between the Orbiter and the IUS
2. Incorporation of a tilt table mechanism for IUS deployment.

The purpose of this Appendix is to describe the effects of these changes on the DSP Mission Plan. To accomplish this purpose, the following topics are individually addressed:

- Nominal Mission A timeline revision
- Earliest IUS burn opportunity
- IUS internal power requirement
- IUS state vector accuracy
- Orbiter/IUS relative motion
- Mission flexibility

E.1 NOMINAL MISSION A TIMELINE REVISION

Figure E-1 shows the revised Mission A timeline accounting for the IUS configuration changes. The revised timeline is based upon the fourth ascending node transfer opportunity and the 14:50:02 GMT launch time as reflected in the original mission plan. The principal differences from the original mission plan are as follows:

- Activation and checkout of the IUS is performed during the 20 min period ending at 3:12:00 GET. This period of activity is scheduled to occur in conjunction with an RTS pass to support checkout of the IUS TT&C system.

These operations occur about 70 min later than in the original plan. Particularly noteworthy is the provision for TT&C system checkout without extending the IUS on the RMS. It is assumed that erecting the IUS on the tilt table makes this checkout possible.

- IUS deployment is accomplished during the darkness period ending at 4:19:00 GET. This is one revolution later than the original mission plan because the RF link between the Orbiter and IUS eliminates the need for two RTS passes between deployment and the first IUS burn. Release from the RMS is scheduled to occur at sunrise to conform with current NASA guidelines.

- IUS attitude control is initiated by a command from the Orbiter after a separation distance of 200 ft is achieved. This occurs within 2 min of completion of the separation burn and is independent of ground stations.

- The Orbiter crew verifies achievement of the 10 n.mi. safe separation distance 64 min after the separation burn. Handover of autonomous IUS control authority to the DOD MCC is accomplished at this time.

- At 05:41:00 GET, the DOD MCC authorizes initiation of the IUS mission sequence. The NASA MCC relays this authorization to the Orbiter crew who, in turn, send the necessary commands to the IUS. This is accomplished without RTS support. From this point, the mission proceeds as presented in the body of this report.

E.2 EARLIEST IUS BURN OPPORTUNITY

Based upon the configuration used to develop the original Mission A plan, it was concluded that the earliest IUS burn opportunity (neglecting satellite deployment longitude requirements) occurred in the vicinity of the fourth descending node. Figure E-2 shows the minimum duration IUS deployment timeline taking into account the configuration changes identified above. In this ideal case, 45 min elapse between the Orbiter separation burn and the Start Mission Sequence Command. A period of darkness is scheduled to end 52 min before the IUS transfer burn so that IUS release from the RMS occurs at sunrise. Minimum duration also requires that an RTS be available approximately 85 min before the IUS burn to facilitate checkout of the IUS TT&C system (if required).

Referring back to Figure 4-3, it is apparent that the IUS activation and checkout could begin as early as 77 min after liftoff. Thus, the earliest possible time for performing the first IUS burn is 2 hr 57 min after liftoff. This time is 17 min after the second ascending node, so the first burn would have to be delayed until the vicinity of the third descending node. Therefore, it is concluded that the IUS configuration changes could permit the first IUS burn to be performed as early as the third descending node. This, however, requires constraining the launch time to provide a period of darkness at the desired deployment time. If the launch time is left unconstrained, the period of darkness can vary by as much as 90 min. Since IUS release is currently constrained by NASA guidelines to occur at sunrise, up to a one revolution delay in IUS deployment may be incurred. This means that, in the worst case, the first IUS burn could still occur as early as the fourth descending node.

E.3 IUS INTERNAL POWER REQUIREMENT

One benefit of the configuration changes is the fact that the IUS can be switched to internal power later in the deployment sequence, thereby reducing the battery lifetime requirement. The original mission plan (Figure 4-3) called for switching to internal power by 2:29:00 GET and deactivating the IUS after 9:17:00 GET yielding a minimum battery lifetime of 6 hr 48 min. It should be noted that the DSP longitude requirement was very favorable. For other longitudes, RTS passes might require deployment several revolutions before the first burn. For example, satellite deployment at 7 deg West Longitude would require the IUS transfer burn to occur in the vicinity of the 14th ascending node. A six-hour gap in RTS coverage exists in this period, thereby resulting in a six-hour coast period between the IUS RCS enable and the SRM enable. A 12-hr battery lifetime would be required to accomplish this mission.

The switch to internal power occurs during the IUS activation and checkout operations which are shown in Figure E-2 to occur between 80 and 100 minutes before the IUS transfer burn. This yields a minimum battery lifetime requirement of 5 hr 12 min if the same transfer as presented in the original plan is used.

As described in the previous section, the worst case daylight/ darkness cycle could require deployment of the IUS up to 90 minutes earlier than ideal. This would increase the battery lifetime requirement to a minimum of 6 hrs 42 min.

Finally, if the IUS transfer burn were to be made at a different node in order to achieve a different satellite deployment longitude, a further increase in battery life may be required. It is assumed that an RTS pass is required to support the IUS activation and checkout operations. Figure 5-7 shows that station passes generally occur at one to two hour intervals, but that gaps lasting up to six hour exist. Thus, it may be necessary to perform the checkout up to six hours earlier than ideal. Therefore, using the transfer trajectory selected for the original Mission A plan, the battery lifetime requirement could still be on the order of 12 hr. This could be reduced by six hours if recharging of IUS batteries by the Orbiter were performed after switching to IUS internal power.

E.4 IUS STATE VECTOR ACCURACY

The accuracy of the IUS state vector at the time of the transfer burn significantly affects the accuracy with which the satellite deployment orbit can be established. The state vector accuracy is closely related to the amount of time between state vector initialization from the Orbiter and the IUS transfer burn. Figure E-2 shows that the minimum time between these events is 64 minutes. As discussed in Section E.2, the worst case daylight/darkness cycle could cause IUS deployment to occur up to 90 minutes earlier than ideal. Thus, the maximum expected time span between state vector initialization and the IUS transfer burn is 2 hrs 34 min.

E.5 ORBITER/IUS RELATIVE MOTION

The DSP mission requirements specify that the Orbiter/IUS separation burn should be a 4 FPS forward RCS translation. In Section 5.7 it was shown that the required 10 n.mi. separation distance for the first IUS burn was easily achievable using this separation technique because of the 1.5 hour coast period following separation. For the minimum duration coast period (45 minutes) shown in Figure E-2, this separation technique cannot provide the required distance. Figure E-3 shows the separation ΔV that results in a 10 n.mi. separation distance as a function of the coast time. ΔV's greater than 4 FPS (the limiting value from a contamination standpoint) are required if the coast period is less than 64 minutes. To overcome this problem, NASA has suggested deploying the IUS with the Orbiter and IUS aligned with the radial direction. The Orbiter then separates with a 1 FPS radial ΔV followed by a larger retrograde ΔV after the Orbiter has moved away several hundred feet. Figure E-3 shows the magnitude of the retrograde ΔV to be comparable to the single impulse ΔV. Thus, about 1 FPS penalty is incurred using this alternative technique. In order to standardize operations, it would be desirable to adopt the same separation method, including ΔV magnitude, regardless of the available separation coast time.

E.6 MISSION FLEXIBILITY

Without the RF link, it was necessary to closely control the time of launch in order to coordinate periods of darkness with ground station coverage. With the link, considerable freedom exists to select the time of launch. Two criteria for establishing launch time are identified as follows:

1. Select the time of launch to provide the ideal day/night cycle for payload deployment as depicted in Figure E-2. This permits no control over the right ascension of the ascending node of the Orbiter parking orbit which, in turn, affects the accessible DSP deployment longitude.

Figure E-4 shows the accessible longitudes as a function of launch time for the DSP mission plan contained in this report (i.e., 1 January 1981 launch date, 4th ascending node IUS transfer opportunity, 137 ±6 deg West longitude DSP deployment point). The larger shaded region shows the acceptable launch times if the target orbit right ascension of ascending node is fixed at 292 deg. In this case, the 137 deg deployment longitude can be reached if launch occurs any time between 14:15:00 GMT and 22:15:00 GMT. If a six degree tolerance on deployment longitude is allowed, launch can occur any time of the day.

If the target orbit right ascension of the ascending node is allowed to vary between 250 deg and 340 deg as discussed in Section 3.2.1, the smaller shaded region of Figure E-4 also becomes accessible. In this case, the 137 deg longitude can be achieved for all launch times exclusive of the period from 01:30:00 to 11:20:00 GMT. The largest error in longitude that would have to be tolerated is 4.8 deg which results from launch occurring at 06:12:00 GMT.

2. Select the time of launch to provide a parking orbit right ascension of ascending node that permits satellite deployment at the desired longitude. As shown in Figure E-4, this excludes launch during about 10 hours of the day. In this case, the day/night cycle for IUS deployment is not necessarily ideal. The time between IUS deployment and the first burn will increase thereby affecting mission accuracy, battery life requirements, RCS propellant consumption and overall reliability.

Obviously, these two criteria are in conflict. Therefore, a tradeoff would be required to consider the relative importance of the advantages available by varying the time of launch.

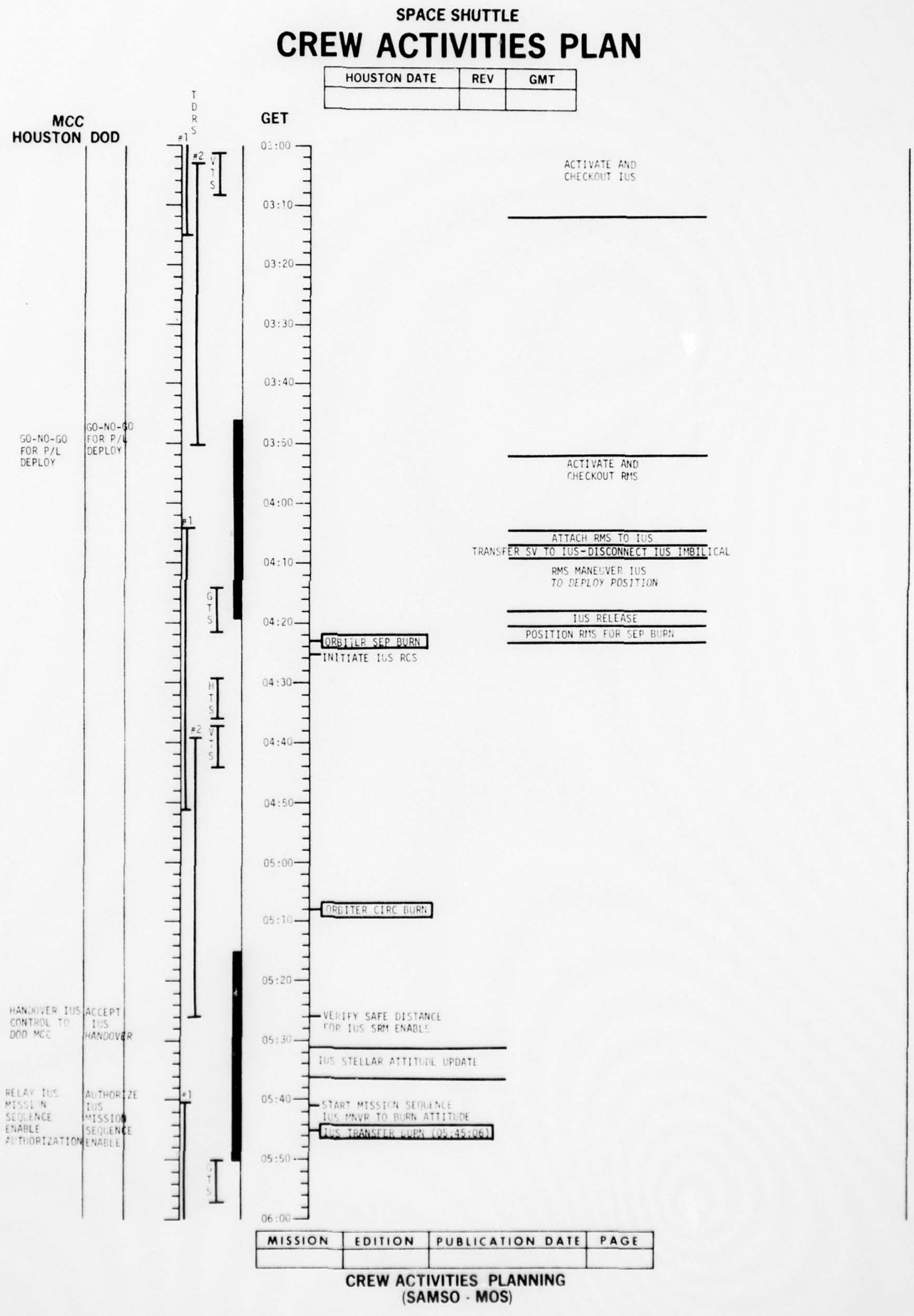


Figure E-1. Revised Mission A Deployment Timeline

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DEPARTMENT OF DEFENSE SPACE TRANSPORTATION SYSTEM (DOD/STS) MIS--ETC(U)
SEP 77 G S GEDEON, J R OWEN, R D TOMLINSON F04701-75-C-0025
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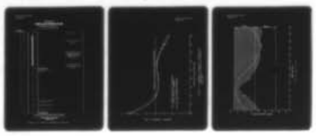

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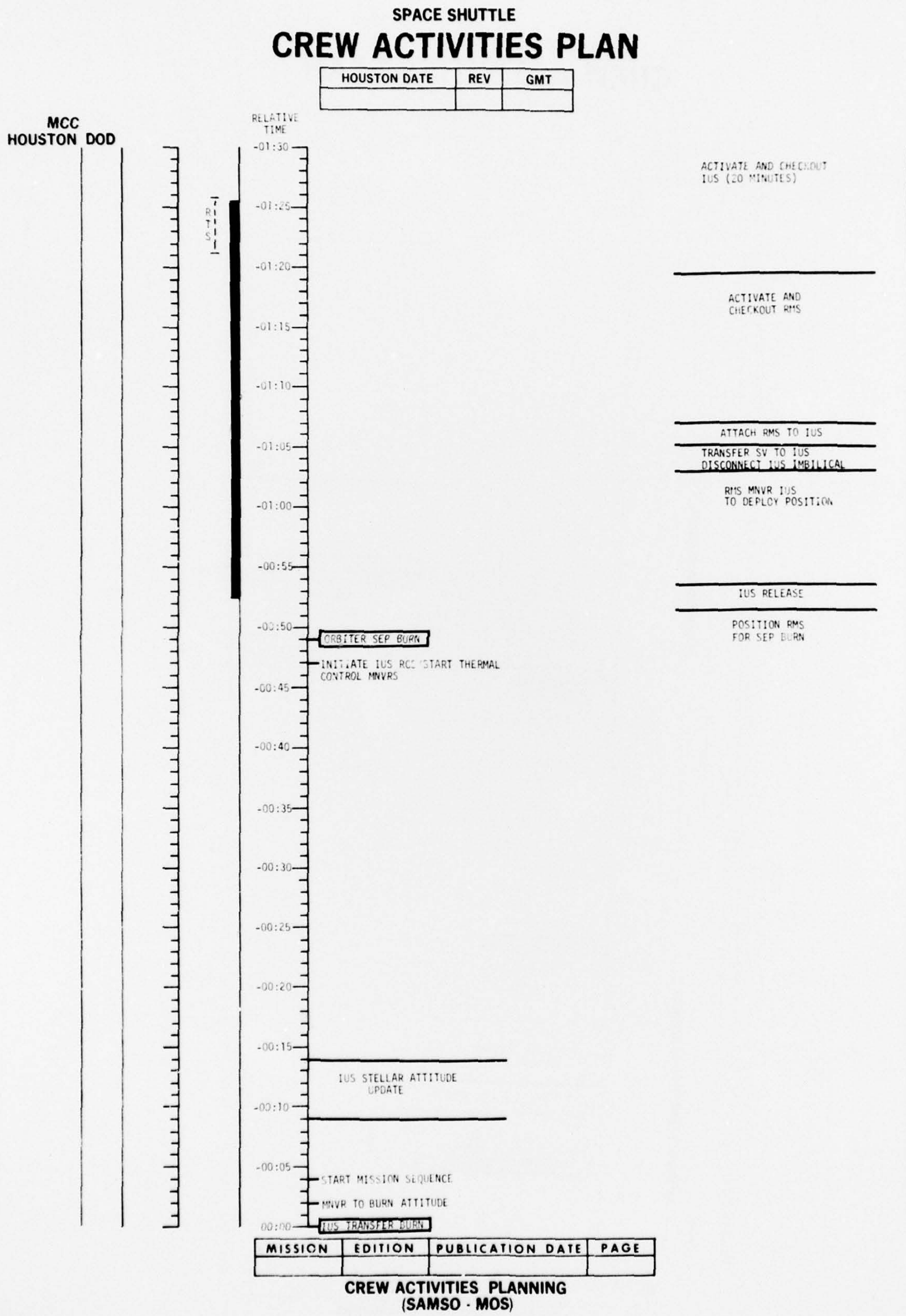

Figure E-2. Minimum Deployment Timeline

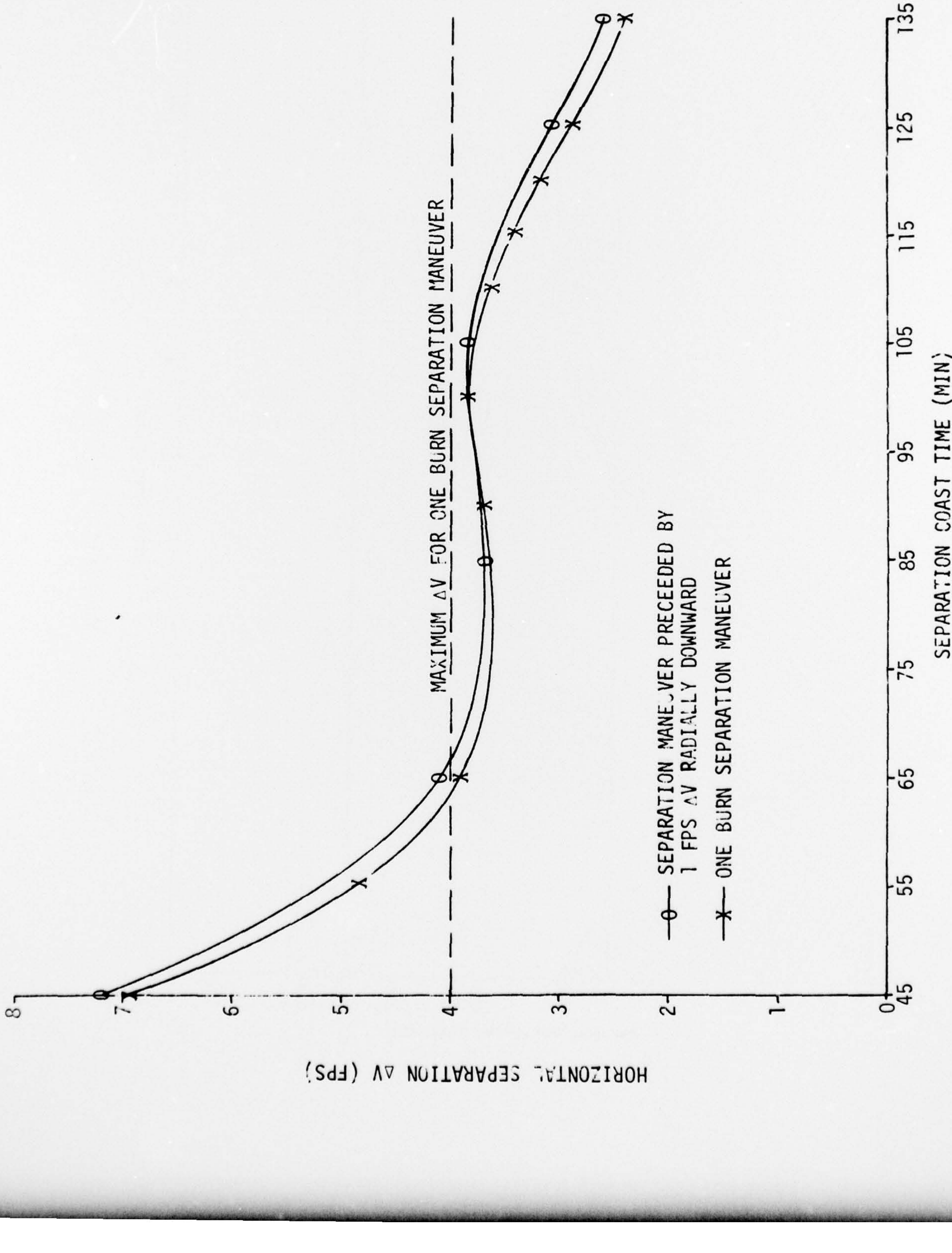

FIGURE E-3. RETROGRADE ΔV REQUIRED TO ACHIEVE 10 NMI SEPARATION AS A FUNCTION OF SEPARATION COAST TIME

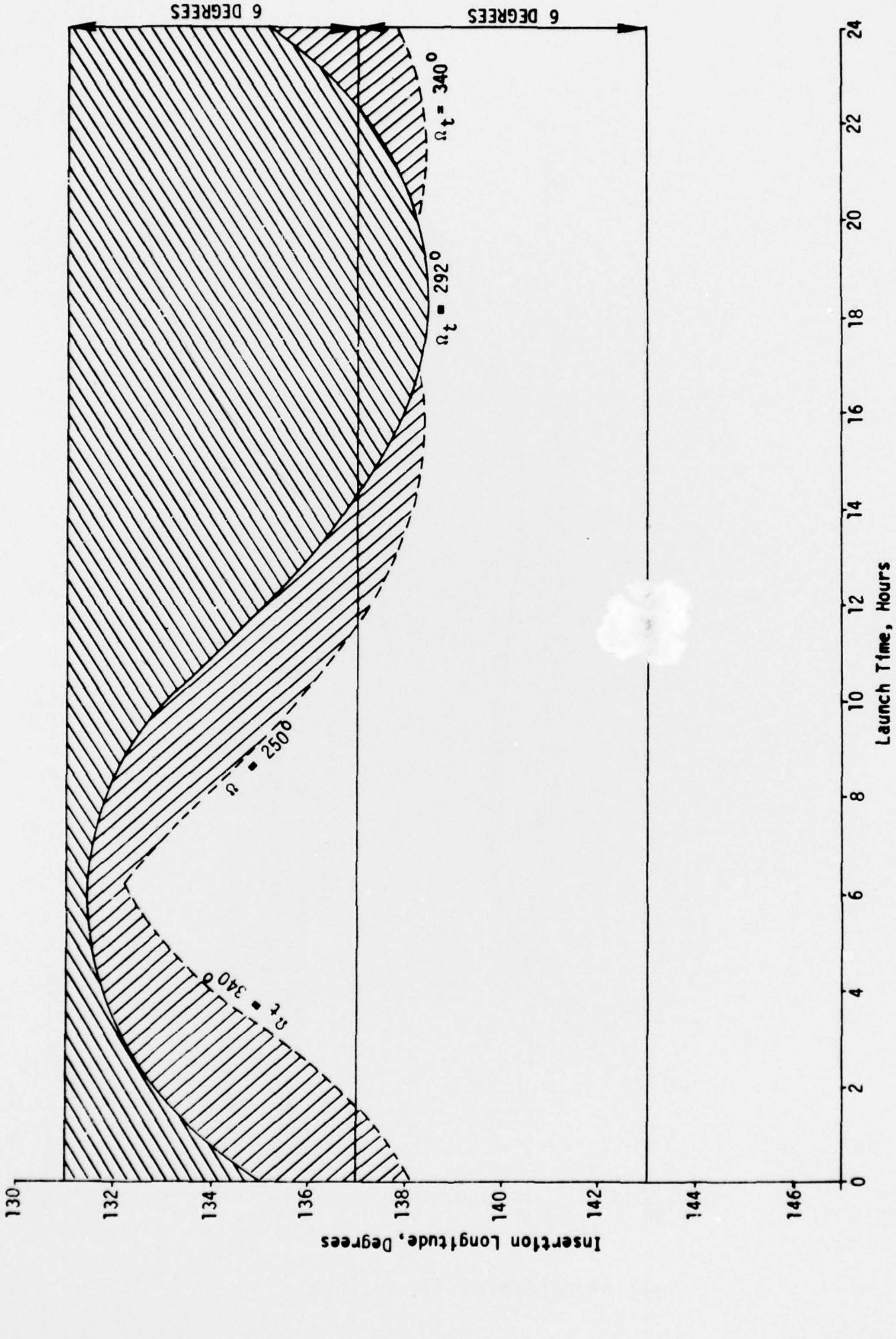

Figure E-4 Launch Window